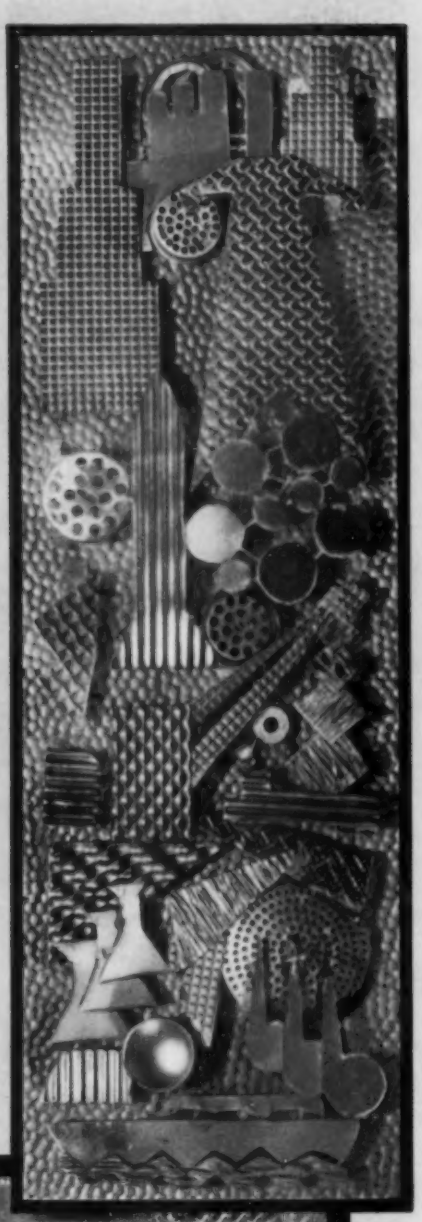
May 12, 1958 PRICE 50 CENTS

Product Engineering

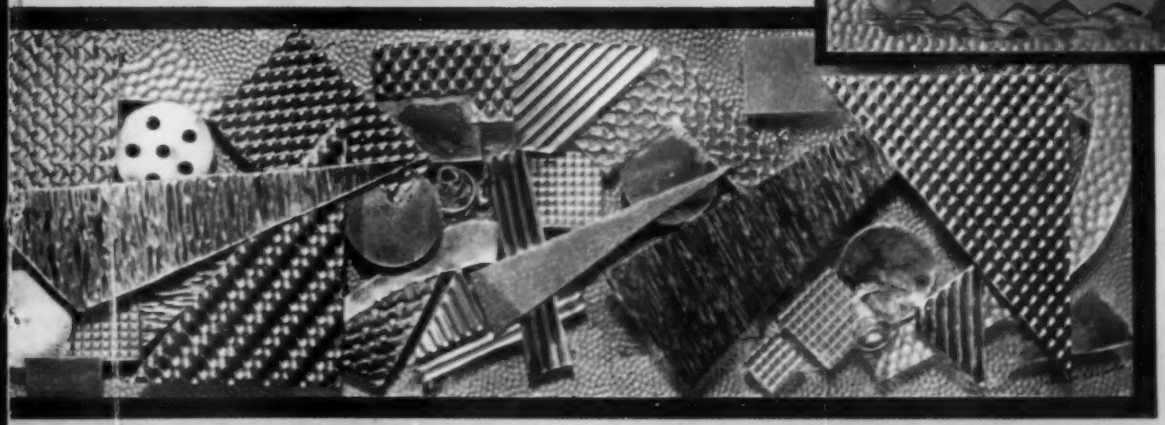
McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOP

DESIGN edition

EDUCATION

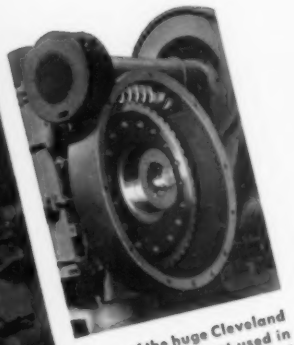


PRODUCTION



DESIGN

see page 5



View of the huge Cleveland Worm and Gear set used in this 150 Series All-Steel Shear, built by The Cincinnati Shaper Co.

CLEVELAND gearing helps this giant shear 1½" steel plate

THE terrific pressures generated in cutting a 1½" steel plate 12 feet long are as nothing to this giant shear. Reason: Because there is plenty of extra power, transmitted through Cleveland Worm Gearing.

Whenever a drive must operate under extreme pressures, there you'll find Cleveland Worm Gearing at its best. And a Cleveland drive stays dependably on the job no matter how severe the service. It doesn't wear out—its efficiency actually improves with use.

Write for Bulletin 145 which illustrates the many types and sizes of units available in Cleveland Worm Gear Speed Reducers and Drives. Our sales representative near you will sit down with you at your convenience to analyze your drive problems and help you select Clevelands best suited to your needs. The Cleveland Worm and Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

CLEVELAND
Worm Gear
Speed Reducers

WHY THINGS RUN SMOOTHER WHEN YOU SPECIFY HYATTS

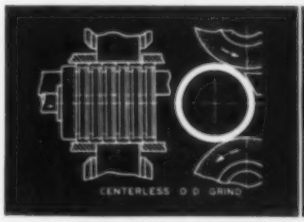
Grinding the flange on a HYATT outer race.

PRECISION FINISHING OF HYATT OUTER RACES HELPS ASSURE LESS HEAT AND VIBRATION . . . BETTER BEARING PERFORMANCE

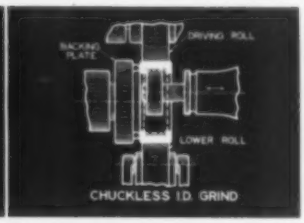
Outer races usually are not the critical members of a roller bearing, but they provide vital fatigue-resistant roller pathways in all applications where hardened and ground housings are not feasible. The better they are built, the smoother and longer the entire bearing will perform.

So HYATT manufactures outer races with the same scrupulous care that is applied to all other components of HYATT Hy-Roll Bearings. After careful primary machining and heat treating, the outer race ends are faced off square and parallel by a double end grind. This provides a reference surface from which all runouts and squareness can be gaged in the subsequent operations shown at right.

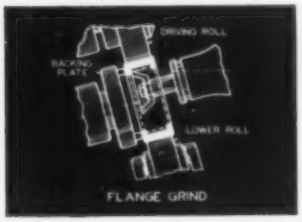
You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Pittsburgh, Detroit, Chicago, and Oakland, California.



Through-feed centerless grinding provides an O.D. with minimum out-of-round and helps reduce costs.

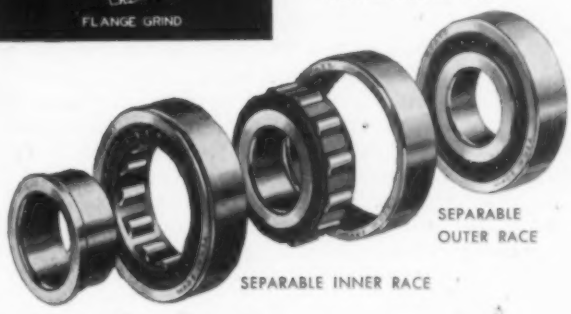


Next, race is driven on O.D. and ground centerless to generate an I.D. cylinder concentric with O.D.



Flanges are ground using race ends as reference. Result is race of as nearly perfect geometry as practical.

NON-SEPARABLE TYPE



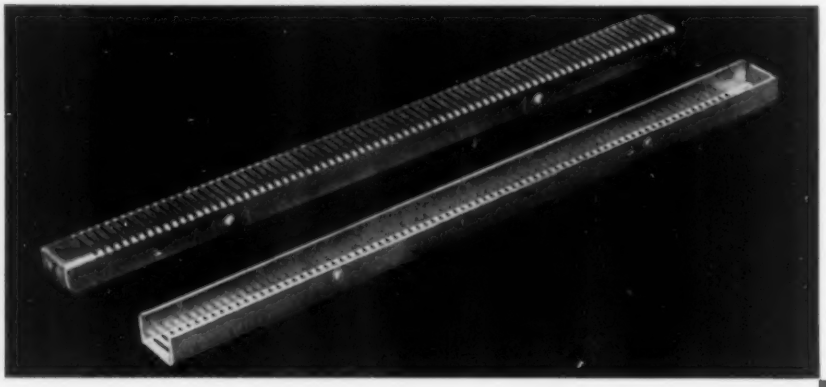
THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

1908–1958 GM FORWARD FROM FIRST

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

USE READER SERVICE CARD FOR MORE INFORMATION

How a redesign job with ARMCO ALUMINIZED STEEL Type 1 cut costs, added new sales points



Simple construction of this burner element, redesigned with Armco ALUMINIZED STEEL Type 1, means it can be more easily cleaned and the heater more easily serviced, both important sales advantages. Besides, Armco ALUMINIZED STEEL not only costs less than the material formerly used, but provides top-notch resistance to both heat and corrosion.

OFFERS COMBINATION OF ADVANTAGES

For many kinds of products, Armco ALUMINIZED STEEL Type 1 offers you advantages not obtainable with either steel or aluminum alone. Sheet steel hot-dip coated on both sides with aluminum, it gives you opportunities to step ahead of competition.

Resists Heat and Corrosion—ALUMINIZED STEEL Type 1 withstands temperatures to about 900 F without discoloration, up to 1250 F without destructive scaling. Its steel base provides strength and rigidity at high temperatures, its aluminum coating protects against corrosion.

Reflects Heat—Up to 900 F, Armco ALUMINIZED STEEL Type 1 reflects about 80% of incident radiant heat, directs heat where you want it for highest efficiency.

Fabricates Easily—ALUMINIZED STEEL Type 1 can be welded by standard methods. The aluminum coating adheres well in moderate drawing and forming operations. Design and fabricating problems are simplified.

Combining the advantages of two metals in one, ALUMINIZED STEEL Type 1 costs less than any other metal that can equal its performance. If your products require heat reflectivity, or resistance to heat and corrosion combined, use Armco ALUMINIZED STEEL Type 1 to cut costs and give them new selling advantages. It's available in sheets, coils, and welded tubing. For complete information, just fill out and mail the coupon.

Armco Steel Corporation
2068 Curtis Street, Middletown, Ohio

Send me information on
- ☐ Armco ALUMINIZED STEEL Type 1
- ☐ Armco ALUMINIZED STEEL Type 1 Tubing

We are considering it for_____

_____

Name_____

Company_____

Street_____

City_____ Zone____ State_____

ARMCO STEEL

Armco Steel Corporation
2068 Curtis Street, Middletown, Ohio • Sheffield Division
Armco Drainage & Metal Products, Inc. • The Armco International Corporation

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

MAY 12, 1958 Vol. 29, No. 19

Midget Batteries—Packaged Power *72... Annesta R. Gardner, Associate Editor
Some are truly dry cells, others tap isotope energy. . . . A growing list of these miniatures is heading for many specialized applications where either current or voltage needs can be kept low.

Cast-in Tubing 76... Herbert L. Kee, Assistant Editor
The method gives inserts that transmit fluid efficiently; combines economy of casting techniques and pressure tightness of tubing. With these design tips, it can give low-cost parts.

Pelletized-magnesium Extrusions 80... G. S. Foerster, Dow Chemical, and H. A. Johnson, WADC
Although they now cost more than regular extrusions, their superior compressive strengths promise radical design changes for large magnesium sections.

Design Features in New Products 82... Flowmeter immune to temperature changes; sewing machines—versatile versus portable; press molds plastics; drills obey escapement.

New Shock Absorber 86... R. M. Sando and F. E. England, Westinghouse Electric Corp.
The load-absorbing core is silicone rubber; so is a restraining girdle that prevents bulging. Result is smooth spring rate plus high energy-absorption ability.

Semiconductoo Rectifier* 89... R. A. York, General Electric Co.
Germanium and silicon are taking the lead. Comparison tells the story. Both materials often cost less than their rivals; yet they perform as well or better.

Latin Squares Reduce Test Labor 92... D. N. Chorafas, Catholic University of America
Why let variables force you to make 64 experiments when 16 will give same accuracy? From an ancient puzzle-game comes this method that deserves wider popularity as a statistical shortcut.

Hydraulic Extrusion—Soviet Style 94... Eugene Gros, London.
Experimenters report much less pressure needed for cold extrusion.

DESIGN FILE

Basic Feeders for Parts 96... P. C. Noy, Canadian General Electric Co.
Review of devices that feed single parts to an assembly station.

Clearance Hole and Drill Sizes 99... C. I. Millard, Sandia Corp.
Two developments combine to take guesswork out of tolerance build-up.

DEPARTMENTS

Interesting to Note	5	New Components, Materials	103
Developments to Watch	19	Catalogs and Bulletins	138
The Engineering Week	21	Tangents	144
Reader to Editor	26	Design Abstracts	149
Design Perspectives	67	New Books	151
Editorial	71	* Current Reprints	157

New Product Announcement

STEMCO TYPE MX* THERMOSTATS

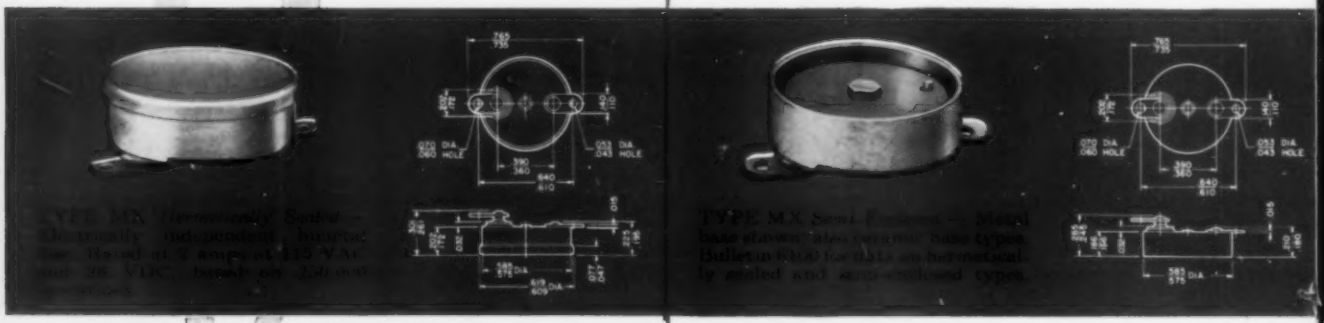
especially designed for missile, avionic and electronic applications

New Stemco Type MX Thermostats are miniature snap-acting units designed to *open* on a temperature rise. Being compact, lightweight units able to withstand high G's under wide ambient temperature ranges, Type MX thermostats are ideal for missile, avionic and other electronic applications where close temperature control is mandatory.

Basic design flexibility of the Stemco Type MX Series means the units can be supplied from regular production runs in a wide variety of models, both semi-enclosed or hermetically sealed. Ceramic or metal bases for semi-enclosed units, round enclosures or CR-7 crystal cans for hermetically sealed units. Several types of terminal arrangements, mounting provisions, brackets, etc., are available.

Stemco Type MX thermostats give you performance . . . small cubage . . . rugged reliability . . . *at a production price.*

*** 2° to 6°F differentials available**



AA-7285

STEVENS *manufacturing company, inc.*
Mansfield, Ohio

STEMCO® THERMOSTATS

ALBERT HAUPTLI *publisher*

ELMER J TANGERMAN *editor*
ROBERT W CARSON *managing editor*

PAUL N ANDERSON *associate editor*
ROBERT E ABBOTT *associate editor*
JOHN KOLB *associate editor*
NICHOLAS CHIRONIS *associate editor*
RICHARD M KOFF *associate editor*
HENRY E COOK, JR *associate editor*
FORD R PARK *associate editor*
ROBERT S PRENTISS *associate editor*
ANNESTA R GARDNER *associate editor*
WILLIAM GILMAN *associate editor*
FRANKLIN D YEAPLE *associate editor*

JOSEPH J KELLEHER *assistant editor*
BENEDICT A LEERBURGER, JR *assistant editor*
DOUGLAS C GREENWOOD *assistant editor*
PHYLLIS B SWEED *assistant editor*
DORA K MERRIS *assistant editor*
HERBERT KEE *assistant editor*
CHARLES J LYNCH *assistant editor*

FELIX GIORDANO *Detroit*
JACK MEYER *Los Angeles*
SETH PAYNE *Washington*

RICHARD E ROOMAN *art director*
E G LOADER *asst art director*
ANGELA M GIACIN *assistant*

NORMA J VAN NESS *production supervisor*
LILLIAN M WITHAM *assistant*

JOSEPH KERR *consulting editor*
ROBERT E BRUCKNER *consulting editor*

DEXTER KEEZER *director economics dept*
GEORGE B BRYANT, JR *washington*
DONALD MacDONALD *Detroit*
WILLIAM G MELDRUM *Cleveland*
STEWART W RAMSEY *Chicago*
MARGARET RALSTON *San Francisco*
JOHN H KEARNEY *Los Angeles*
MICHAEL J MURPHY *Los Angeles*
RAY BLOOMBERG *Seattle*
CHARLES T DIXON, JR *Atlanta*
KEMP ANDERSON, JR *Dallas*
JOHN WILHELM *editor, world news*
JOHN TUNSTALL *London*
JOHN SHINN *London*
RICHARD MARBOIS *Paris*
RICHARD A LAWRENCE *Milan*
RAYMOND SHAH *Zurich*
ONNIC M MARASHIAN *Beirut*
PETER WEAVER *Mexico City*
JOHN PEARSON *Caracas*
SILKE BRUECKLER *Bonn*
SOL SANDERS *Tokyo*

STANLEY J ALLING *associate publisher*
PHILIP G WEATHERBY *advertising sales manager*
P F PRITCHARD *manager, market research*
ROBERT C MATTOON *circulation manager*
C C KANE *reader service manager*
RUSSELL T DOUGLAS *business manager*

Interesting to Note . . .

First, Know the Artist

When he was seven years old, young Rene amused himself in his mother's kitchen by carving a piece of wood. His sister, impressed by his whittlings, soon gave him a pocket knife and the career of Frenchman Rene Shapshak was underway. By the time he was 14 he was already using life models in his work. After studying at art schools in France, England and Belgium, M. Shapshak began to travel—Europe, Africa, then the United States. His impressive list of sculptured busts include Mahatma Gandhi, General de Gaulle, Yehudi Menuhin and Harry S. Truman. Shapshak is represented in museums throughout the world. His works hang in the private collections of Queen Elizabeth and Baron Rothschild.

The murals on our cover are an example of his current work. With hope that his designs will soon be incorporated in full wall or ceiling murals, the sculptor shows how textured stainless steels (*PE—Mar. 17. p. 73*) may be used for artistic expression. (The material was given to him by the Rigidized Metals Corp. of Buffalo).

But is this art? "Of course," says Shapshak, "if it expresses the soul and emotions of the creator, it's art. Yet, 'art' cannot be universally defined. We must all adapt our own definition. To me, it is the aesthetic and cultural influence of an individual expressed in form and color for tomorrow." "Tomorrow" is perhaps the key in Shapshak's work. "Nothing can be created for today, every artist must look ahead," says Shapshak. "The world is progressing; how then can the artist remain behind?"

Asked about his contemporary designs, Rene Shapshak explains his work as experimental. In the past, he says, stone and occasionally wood was the artist's media for expression. Now, there is no limit to the methods and materials the sculptor has in his grasp. The artist today is also a bit of a scientist, constantly coming up with new materials with which to work. Where the sculptor of yesterday had three dimensions at his disposal, Shapshak says he uses seven—"Height, width, depth, time, psychology, science and feeling." Our cover is an example of his 7-D art.

To judge and evaluate contemporary art, Shapshak believes one must know both the creator and his works. Van Gogh was appreciated only after his death; not until then did the world know and

(Continued on page 7)

Product Engineering

A McGRAW-HILL PUBLICATION

May 12, 1958 Vol. 29, No. 19

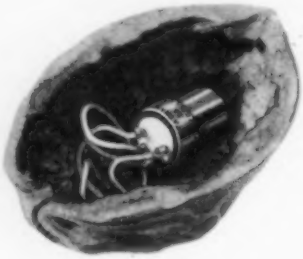
PRODUCT ENGINEERING is published weekly, with an additional Design Digest Issue in Mid-October, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. PUBLICATION OFFICE, 99-129 North Broadway, Albany 1, N. Y. See panel right for directions regarding subscription or change in address.
EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W. 42nd St., New York 36, N. Y.

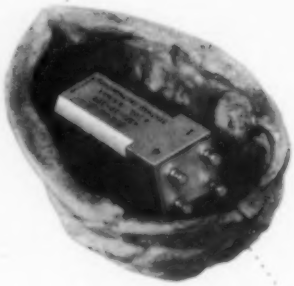
Donald C. McGraw, President Joseph A. Gerardi, Executive Vice-President; L. Keith Goodrich, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publication Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; A. R. Venezian, Vice-President and Circulation Coordinator.
Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. **Position and company connection must be indicated on subscription orders. Send to address shown in box at right.**
United States subscription rate for individuals in the field of the publication, $5.00 per year, single copies fifty cents; Canadian subscription $7 per year; foreign $25 per year, payable in advance. Second-class privileges authorized at Albany, N. Y. U.S.A. © Copyrighted 1958, McGraw-Hill Publishing Company, Inc., all rights reserved.
PRODUCT ENGINEERING articles are indexed in both the **Industrial Arts Index** and the **Engineering Index**. PRODUCT ENGINEERING publishes its own semi-annual index including the Design Digest issue. Copies are obtainable on request to the Editor.

SUBSCRIPTION. Send subscription correspondence and change of address to Fulfillment Manager, PRODUCT ENGINEERING, 330 W. 42nd St., New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, and including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Since copies are addressed one to two issues in advance, please allow one month for change of address to become effective.

Postmaster: Please send form 3579 to PRODUCT ENGINEERING, 330 W. 42nd St., New York 36.

miniaturization in a nutshell





STATHAM MODEL P222 flush diaphragm pressure transducers... for the measurement of absolute, gage, or differential pressures.
DIMENSIONS: .25" diam. x .47" long
WEIGHT: 3 grams, approx.
RANGES: 0-10 to 0-200 psia, psig, or psid; ±5 to ±25 psid.
NON-LINEARITY & HYSTERESIS: Not more than ±1% fs
TRANSDUCTION: Resistive, complete bridge; Statham unbonded strain gage

STATHAM MODEL A52 linear accelerometer...
DIMENSIONS: .32" wide x .35" high x .84" long
WEIGHT: 8 grams, approx.
RANGES: ±5 to ±100 g
NON-LINEARITY & HYSTERESIS: Not more than ±1% fs
TRANSDUCTION: Resistive, complete, balanced bridge; Statham unbonded strain gage

Statham's line of miniature transducers for the measurement of pressure and acceleration are constructed to give accurate, reliable service in applications which demand critical space requirements. These rugged, laboratory-calibrated instruments are especially suitable for use in the supersonic aircraft and missile fields.
If there are critical space problems in your instrumentation program, the requirement for accuracy and reliability need not be sacrificed...when you specify Statham. Our application engineers are always ready to help with your instrumentation problems.

*Model shown actual size. Complete technical data are available upon request.

Statham INSTRUMENTS, INC.

12401 W. Olympic Blvd., Los Angeles 64, California

understand him as a person, and see in his work how his personality manifested itself. "This is also true today," says Shapshak. "We must know the artist's inner self before we can truly see his work." Rene Shapshak is a lonely man, yet he feels that his style of expression is today being accepted and understood by more and more people. He takes consolation in the belief that the "contemporary artist will lead us in design, for art has always been in the forefront of the battle for industrial and cultural development."

It Happened Before Galvani

Twenty years ago, the German archeologist Wilhem Konig was digging into a small hill in Iraq called Khujut Rabu's. Before long, he unearthed the remains of an ancient Parthian village. From museums came more archeologists and before long the ancient town was completely excavated. Among the various artifacts that caught Konig's attention was a peculiar object shaped very much like a dry-cell battery. He checked further and found four similar-shaped objects in the vicinity. In the ruin of an old alchemist's shanty down the river, he unearthed thin bronze and iron rods that resembled connecting wires. Konig returned to the Berlin Museum where he found the diggings had uncovered more parts—cylindrical copper containers, more iron rods and bits of asphalt. He reported his findings in a book and mankind wondered whether the early Parthians had beaten Luigi Galvani in discovering the "galvanic" cell. (*PE—Dec. '56, p. 7*)

Although Alexandro Volta is first credited with connecting Galvani's cells in a row, thus producing a "battery," it is now believed that Mesopotamian silversmiths made the same discovery 2000 years previously and used their batteries to gold-plate jewelry. Batteries are familiar to all, yet their potential uses have only begun to be explored. The article on page 72 discusses new miniature batteries offering high voltage, long life and broad operating ranges.

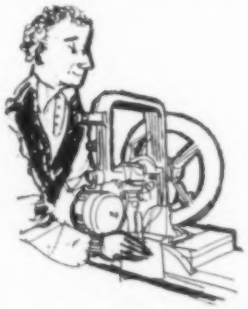
Rising Rivers

The picturesque New England countryside owes much to its decorative rivers and streams. But in 1955 they overflowed their banks. Newspapers reported some homeowners getting off their property only moments before their homes were carried away. Bridges collapsed, communications gave out, Governors declared State emergencies; 813 homes were destroyed; total damages was about $458 million. New Englanders were meeting the havoc of flood which has long plagued dwellers along the Mississippi, Missouri and Ohio Rivers.

How to have warning sufficiently in advance? To anticipate floods, Egyptian priests measured the rise and fall of the Nile with instruments called nilometers. In more recent years, river problems have been studied with expensive scale models. By applying highly complex equations of the partial differential type, mathematicians have been able to successfully predict what a certain river would do. The only hitch is the time element—before results are available it's too late.

Now mathematicians have computers like Univac, which recently took only two hours to figure the variables and predict what the Ohio River would do two weeks hence. Floods will always be an enemy, but now we have time on our side.

It is this problem of variables that complicates much prediction-making. Can the mathematicians weed out many of them and thus get around need for a computer in many cases? Yes. Latin squares (p. 92) may be employed to reduce the labor in such a satsistical study.



Howe to Do It

When his lame legs made it impossible to do heavy work, Elias Howe left his father's farm and got a job in a machine factory. He held this job for several years, then worked with an instrument maker in Boston named Ari Davis. One day in Davis' shop a customer asked an inventor who stopped by the store, "Why don't you make a sewing machine?" The inventor replied, "That's impossible. Knitting machines and looms, yes, but no machine can sew."

"Nonsense," said Ari Davis, "I could make a machine that sews."

"You do it, Davis," said the inventor, "and I'll guarantee you an independent fortune."

Davis never did, but the thought of an "independent fortune" excited young Howe. Married, with three young mouths to feed, he was living in poverty. So, in his spare time Howe tried to build a machine that sewed. All his efforts were an attempt to copy the motion of human fingers. As Cyrus McCormick found with his reaper (*PE—Feb. 3, '58 p. 7*), a mechanical device to copy the movements of the body was almost impossible. Howe tried making fingers hold needles. No good. Then he tried a needle with the eye on top, but it snagged and jammed. Such failures didn't stop him. The revolutionary concept of putting the eye of the needle in its point instead of its head was the breakthrough Howe needed. In 1895, six years after hearing an inventor say "impossible," Elias Howe had a machine that would sew a seam. His machine was quite remote from the automatic sewing machines pictured on page 83, but for Howe, it did mean his fortune.

—Benedict A. Leerburger Jr.

WHAT THE DESIGNER CONCEIVES . . . ALUMINUM ACHIEVES

ALUMINUM'S PRESENT WIDE USE and its increasing importance in all types of fabricating are helping create advanced concepts throughout the fields of metalworking and design.

For screw machine production in particular, aluminum machining has pointed the way to new, better and faster methods of parts production for all ferrous and non-ferrous metals. For example—thanks to aluminum—speeds of equipment are common today which a few years ago would have appeared almost unbelievable.

What are the advantages of screw machine production? To help designers make full use of up-to-date developments, the following checklist presents 12 advantages of modern screw machine production:

1. Starting material is a wrought product which gives high properties in the finished part.
2. Very fine threads possible—as well as accurate threading.
3. Excellent finishing possibilities—anodizing, etching, buffing, etc. As-machined finish gives very fine surface.
4. Closer tolerances and more intricate parts possible than with other methods. Mating parts match better.
5. Excellent concentricity is guaranteed.
6. Fewer rejects for porosity when compared to a cast part.
7. Lower costs for production tooling, dies, set-up; faster delivery of finished parts possible due to fast availability of tooling, speed of set-up.
8. Modification of parts in production easier and less costly.
9. Wide range of equipment and facilities available throughout the country.
10. Fewer secondary operations necessary; possible to avoid secondary finishing by using the as-machined surface.

11. Lower costs for actual production due to high rates of production with available new equipment.

12. Lower costs for finished parts due to competitive pricing among large number of suppliers.

ALUMINUM IN SCREW MACHINE PRODUCTION offers designers more useful properties than any other metal. Check this list of 12 aluminum advantages:

1. Light weight—moving parts present less resistance to applied force, wear less; chips float out of recesses better for cleaning finished parts. Easier handling of raw material in plant, lower freight costs on finished parts.
2. Non-magnetic.
3. Corrosion resistant—can often eliminate finishing.
4. Non-sparking.
5. Lower raw material cost per part.
6. Greater conductivity—helps dissipate machining heat.
7. Some alloys less susceptible to radiation absorption.
8. More alloys available than some other metals, allowing a particular alloy to be related to a particular part.
9. Less price fluctuation on raw materials.
10. Stock readily available. Size range broad and well stocked at distributors throughout the country.
11. New procedures in producing aluminum screw machine stock now give greater tool life and higher production. New processes such as Electrofilming and Kanigen Coating also have overcome old problems such as galling and binding.
12. Technical literature for designing purposes readily available.

For further information and expert assistance, call the Kaiser Aluminum sales office or distributor listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc., *Executive Office*, Kaiser Bldg., Oakland 12, California; *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois.

See "MAVERICK", Sunday Evenings, ABC-TV Network. Consult your local TV listing.

For The Competitve Edge, Go Aluminum

KAISER ALUMINUM

THE BRIGHT STAR OF METALS

Riveting With a Hammer in Blind or Open Applications

Elimination of special riveting tools can mean faster production, lower costs, no down time.

J. K. BARRY, M. E.

The use of blind rivets installed with only an ordinary hammer from one side of the job offers a highly simplified method of fastening. Speed, convenience and *low installed cost* make Drive Riveting preferable not only for blind joints, but for fastening many parts that can be reached from either side.

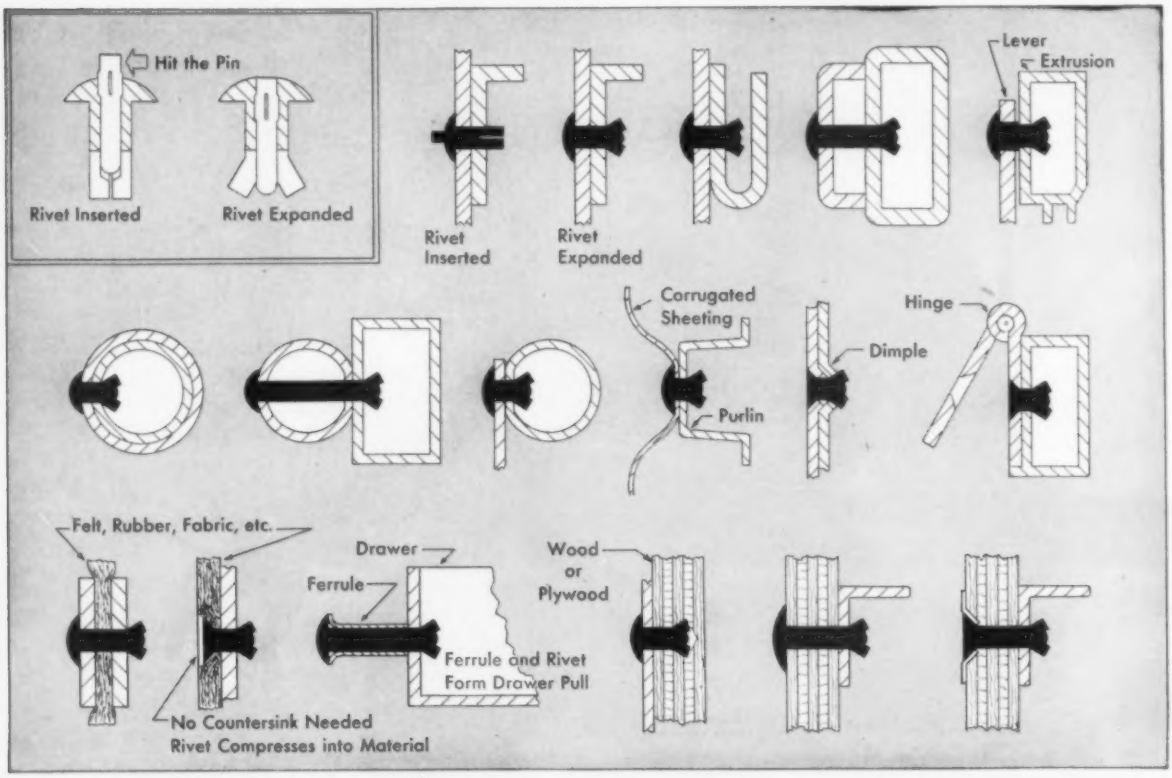
The Southco Drive Rivet has a cored, slotted body with a grooved pin protruding from its head. When the rivet is inserted through parts to be fastened, the pin is driven flush with the rivet head causing the expanding prongs to form a blind head behind the rear sheet. No further finishing is necessary, since the pin seats itself permanently to complete the smooth head contour.

Drive Riveting has five major advantages:

1. No investment in special tooling.
2. No lost time for tool repairs.
3. No limitation on the number of men who can install rivets.
4. Speed comparable to nailing.
5. Only one man is needed.

Widely used in truck bodies, storm doors, metal buildings and hundreds of other industrial applications, Southco Drive Rivets make a secure, vibration resistant joint. A wide range of head styles, diameters and grip lengths is available.

RECOMMENDED APPLICATIONS FOR DRIVE RIVETING



SOUTHCO FASTENERS
LION
©1956

Southco Div., South Chester Corporation
236 Industrial Highway, Lester, Pa.

Self-aligning

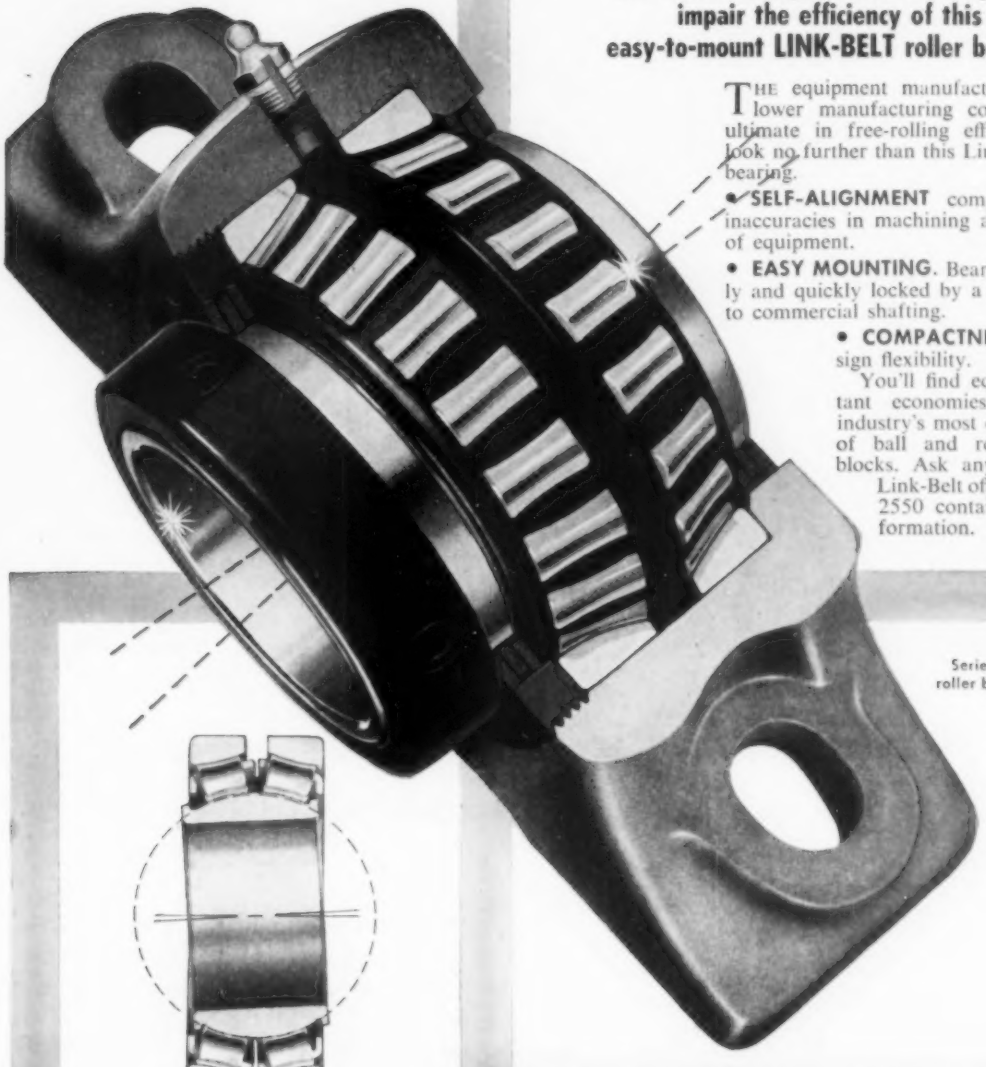
FOR LONGER LIFE

Not even misaligned shafts or supports impair the efficiency of this easy-to-mount LINK-BELT roller bearing

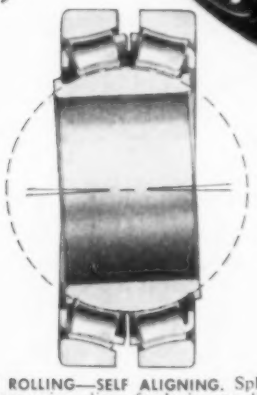
THE equipment manufacturer seeking lower manufacturing costs plus the ultimate in free-rolling efficiency need look no further than this Link-Belt roller bearing.

- **SELF-ALIGNMENT** compensates for inaccuracies in machining and assembly of equipment.
- **EASY MOUNTING.** Bearing is securely and quickly locked by a heavy collar to commercial shafting.
- **COMPACTNESS** offers design flexibility.

You'll find equally important economies throughout industry's most complete line of ball and roller bearing blocks. Ask any one of 40 Link-Belt offices for Book 2550 containing full information.



Series 400 roller bearings

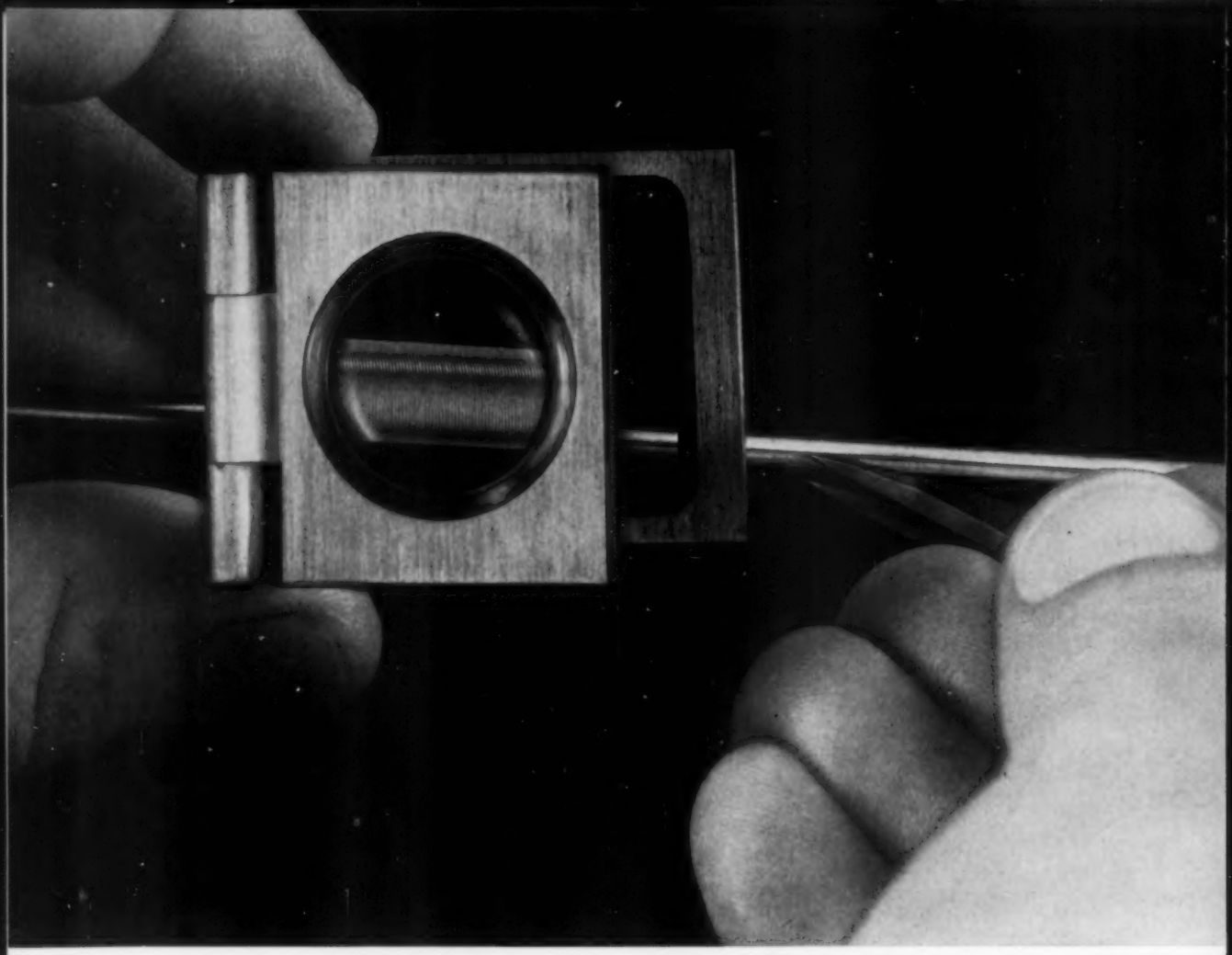


FREE ROLLING—SELF ALIGNING. Spherical inner ring aligns freely in any direction. Load is distributed over entire roller, assuring full capacity. Destructive edge loading cannot occur.

LINK LB BELT

self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.460-A



How "high fidelity" in music spring wire licks a big production problem

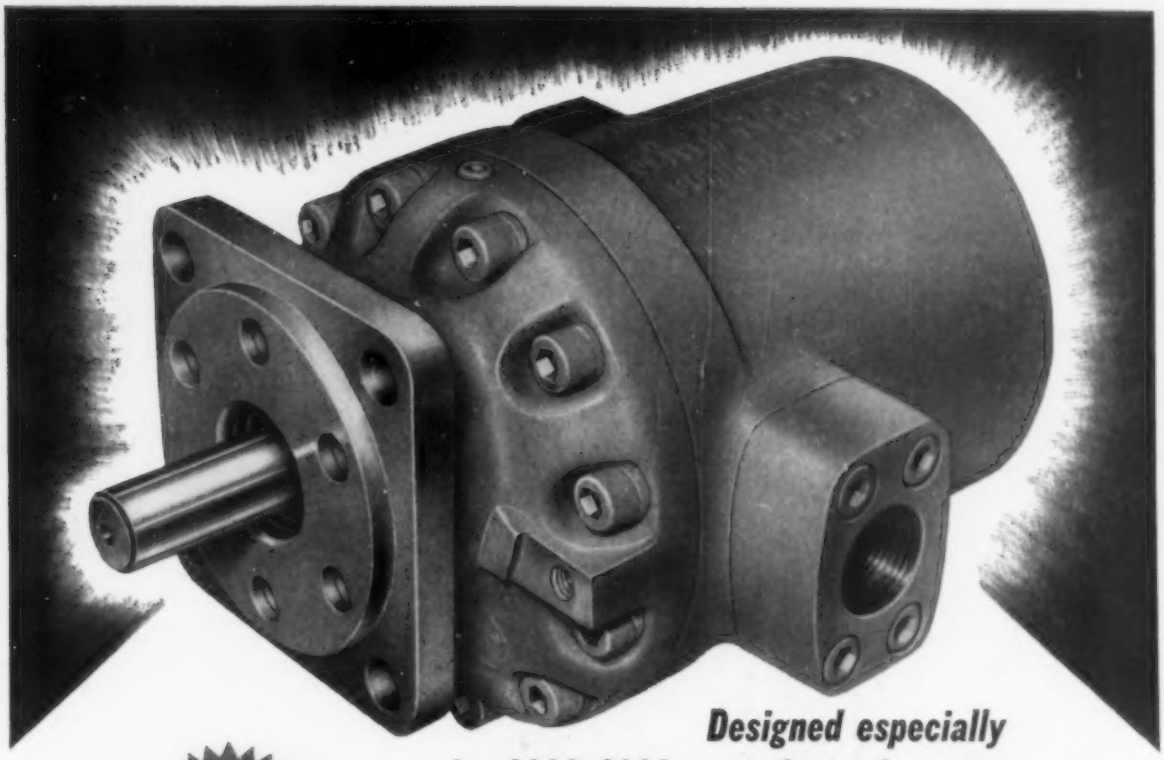
Leading producers of carbon paper apply the carbon coating by means of steel rods closely wound with hair-fine music wire. The wire-to-wire valleys, as determined by wire diameter, control the amount of carbon deposited.

Here is a case where product quality and smooth, uninterrupted production are both dependent on extreme uniformity in the fine wire being used—extreme uniformity in diameter, finish and temper.

This super-critical wire is produced by the Worcester Wire Works Division of National-Standard. Because it does the best job by production comparison, it's naturally preferred. Keep this in mind and check with the Worcester Wire Works Division on your next need for fine wire if quality control is at all a factor. You'll get the finest of *service*, too!

NATIONAL NS NATIONAL-STANDARD **STANDARD**

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *fine wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *music spring, stainless and plated wires, high and low carbon specialties*
WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*



Designed especially for 2000-3000 psi industrial service...

The NEW BERRY HYDRAULIC PUMP/MOTOR

Has these important features:

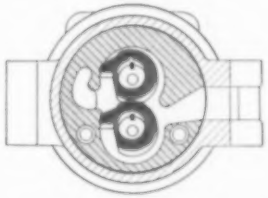
- ★ **Maximum torque at "stall"**
- ★ **Design proven in oil, gas, elevator and lumber industries**
- ★ **Competitively priced**
- ★ **Will carry overhung chain or belt loads**
- ★ **Flange or foot mounted**
- ★ **Instantly reversible**
- ★ **Smooth, constant torque at all speeds**

Write

for complete information and data on suitability for your application.

BERRY HYDRAULICS

A DIVISION OF OLIVER TYRONE CORPORATION
ROOM 2243 OLIVER BUILDING, PITTSBURGH 22, PA.



Schematic diagram above shows one of the two sets of pistons in the sturdy Berry Rotary Piston design.

CHARACTERISTICS

Models A-12 and A-12B

Drive Shaft Rotation	Reversible
Working Pressure	2000 psi
Surge Pressure	3000 psi

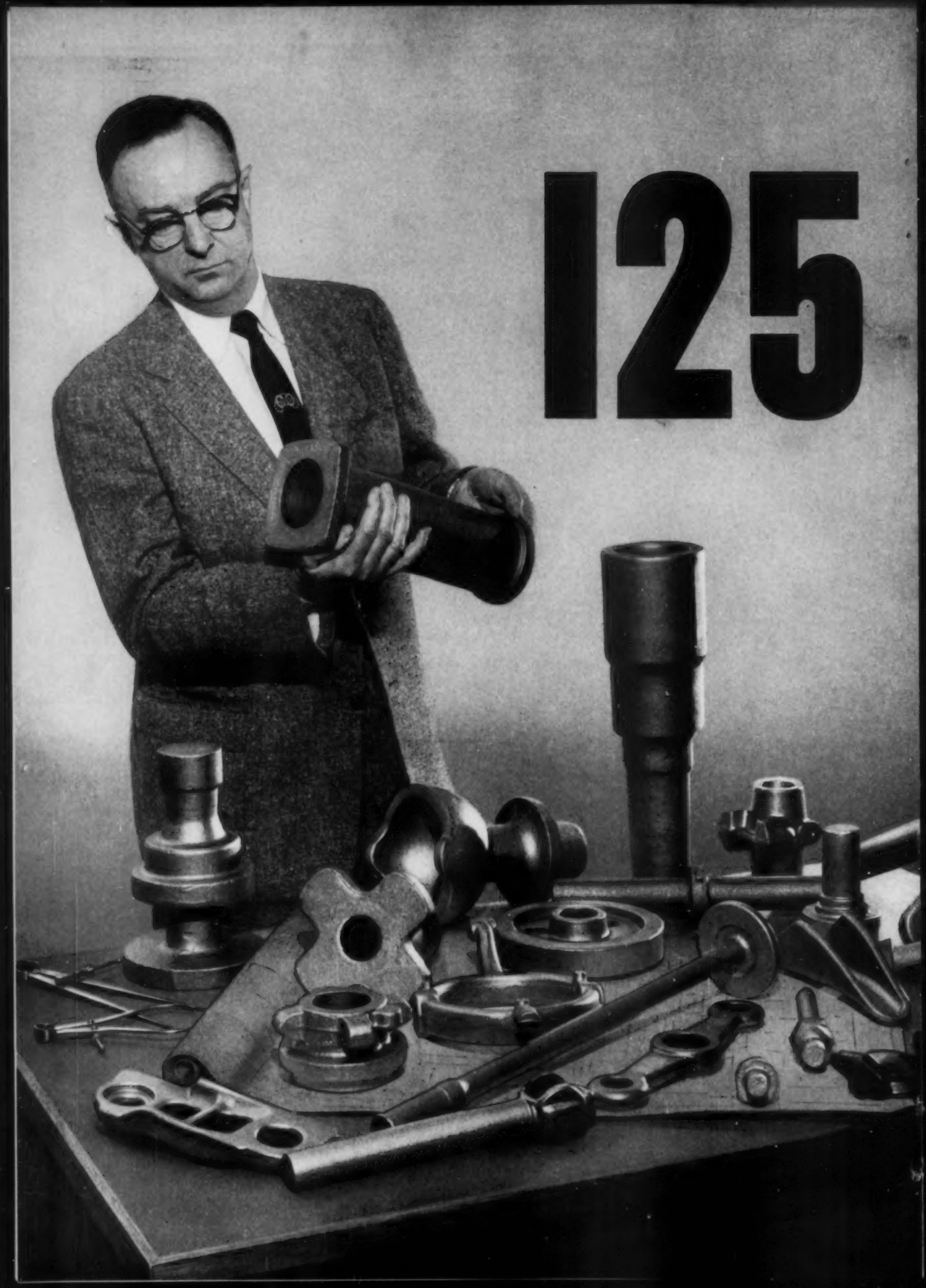
Operated as a Pump

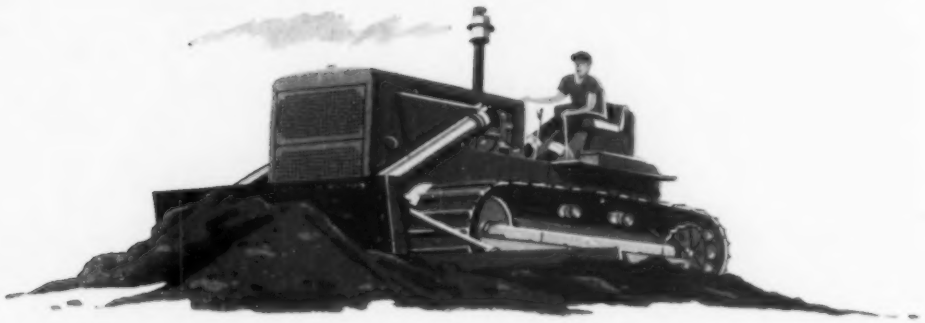
Drive Shaft Speed—Maximum	1200 rpm
Displacement	12 gpm*

**Capacities from 7.5 to 12 gpm at rated speed are also available.*

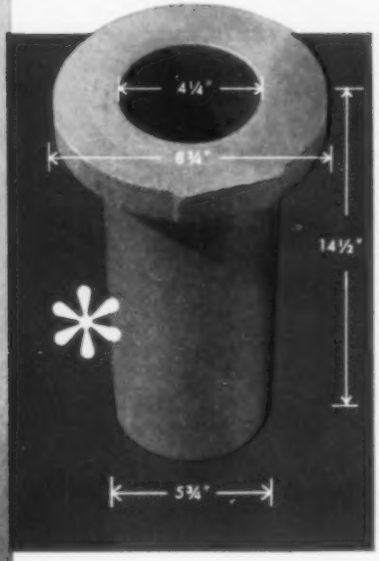
Operated as a Motor

Drive Shaft Speed—Maximum	1800 rpm
Displacement—CIR	2.356
Displacement—GPR	.0102
Theoretical Torque inch lbs./100 psi	37.4


125



FORGINGS for one machine



Sounds fantastic doesn't it? Yet, we have been producing forgings for leading equipment manufacturers for 2½ decades. They depend on AmForge to provide the forging facilities and engineering they need. Continuous, uninterrupted on-the-job service is the most important requirement of a machine. Forgings provide this dependability. We invite you to use our research engineering and production know-how for your development work.

✻ *This rear axle housing for a tractor is interesting because it is forged from tubing stock. AmForge engineers determined that this method would save weight and material since no finishing or drilling would be required internally.*

Brake Shoe

AMFORGE DIVISION

155 North Wacker Drive, Chicago 6, Illinois
Plants: Chicago, Illinois (two) • Azusa, California

This descriptive catalog

FREE

16-page facilities catalog to explain what, how and where AmForge can be of assistance to your firm.

AmForge Division, Dept. PE-58
155 North Wacker Drive, Chicago 6, Illinois

Gentlemen: Yes, I would like to see your catalog.

Send me____copies.

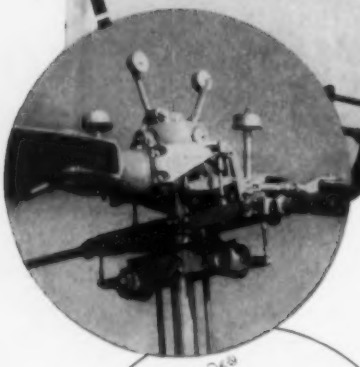
*Name*_____

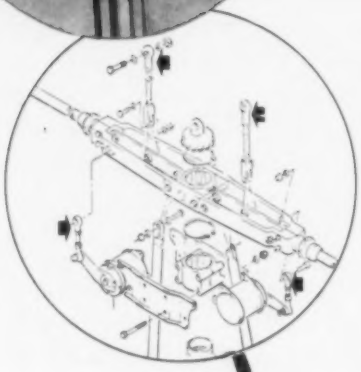
*Title*_____

*Company*_____

*Street*_____

*City*_____ *Zone*____ *State*_____





THE NEW "BELL RANGER" HELICOPTER USES HEIM UNIBAL ROD ENDS

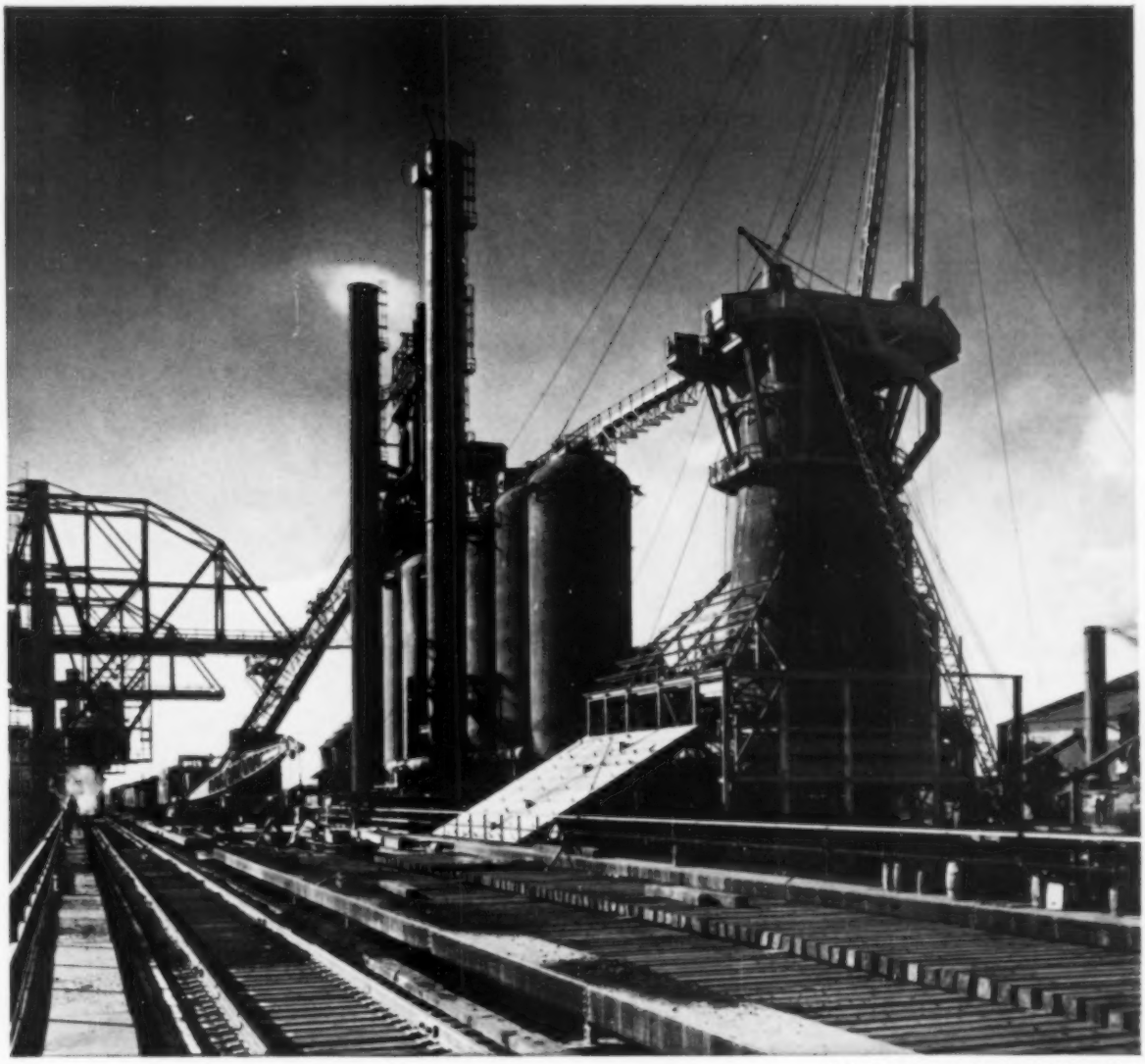
Model 47-J is the latest helicopter to be introduced to the commercial market by Bell Helicopter Corp., and has been named the Bell Ranger. It is a four-place, executive type machine with a deluxe interior or a series of quick-change cabin arrangements for cargo, litter, and internal hoist configurations.

HEIM Unibal Rod Ends were chosen for the linkages in the carburetor heat and mixture control installations, and in the main rotor stabilizer bar assembly. The rods link hydraulic dampers to the bar, which provides exceptional stability to the flight characteristics of Bell helicopters, acting like a gyroscope and, through mixing levers, keeps the rotor plane of rotation in its pre-established flight path.

THE HEIM *Unibal* is the spherical bearing which corrects misalignment in every direction because of the universal movement of the ball — Reduces friction and lost motion in linkages — Eliminates the effects of vibration — Lowers assembly costs because of its quick and easy installation — Carries heavier loads.

Perhaps Heim can help solve — or simplify — your linkage problems. Feel free to write. Be sure each engineering and purchasing department has a Heim catalog.

THE HEIM COMPANY / Fairfield, Connecticut



Under construction—Trenton, Michigan, Plant

McLouth Blast Furnace No. 2

The second major expansion in four years is nearing completion at McLouth Steel.

We are again adding to our facilities to bring you better steels for the product you make today . . . and the product you plan for tomorrow.

McLouth Steel Corporation

Detroit 17, Michigan

Manufacturers of high quality stainless and carbon steels.

Eastman

HIGH PRESSURE ASSEMBLIES

for

Responsive POWER

INSTANT response means extra POWER. Improving the "Power-Performance Ratio" of your equipment may mean an extra bucket per minute, extra tons per hour, extra loads per day.

With the increasing emphasis on POWER, it pays to safeguard the most important link in your hydraulic system with Eastman *High Pressure* Hose and Tube Assemblies.

Eastman Coupling Design gives you maximum orifice, consistent with essential safety and strength, to provide "trigger-response" through unrestricted flow from pump to point of work—plus prompt return.

BENT TUBING TO YOUR SPECIFICATIONS

Eastman's modern, hydraulically-controlled tube bending equipment provides bent tubing to your precise specifications—made with flared or beaded ends for your required fittings. Quality workmanship assures satisfactory performance. Mass production economies assure competitive quotations.

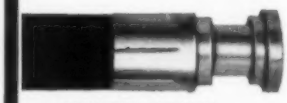
For positive power delivery and efficiency throughout your hydraulic system—plus appearance and sales appeal—it pays to specify Eastman High Pressure Hose and Tube Assemblies for your original equipment.

PERMANENTLY ATTACHED MALE (NPTF)

America's most popular OEM Coupling for 1, 2, and 3 wire braid rubber cover hose, and 4 spiral wire extra high pressure hose.
Sizes: 3/16" thru 3".
Working Pressure: 375-5000 p.s.i.

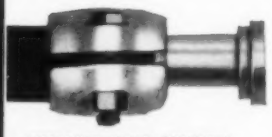
PERMANENTLY ATTACHED SWIVEL FEMALE

Eastman permanently attached couplings give you **a bond stronger than the hose itself!** For 1, 2 and 3 wire braid rubber cover hose.
Sizes: 3/16" thru 2".
Working Pressure: 375-5000 p.s.i.



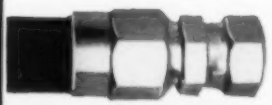
PERMANENTLY ATTACHED FLANGE HEAD COUPLINGS

A no-thread, no-leak "O" ring connection, with split flange and insert available in angles from 0°-90°, for 1 and 2 wire braid rubber cover hose.
Sizes: 1/4" thru 2".
Working Pressure: 375-5000 p.s.i.



INTER-LOCK® CLAMP COUPLINGS

Exclusive Combination: Clamp-type coupling with "Inter-Lock" feature and blowout-proof split flange for 1 and 2 wire braid rubber cover hose.
Sizes: 1/4" thru 2".
Working Pressure: 375-5000 p.s.i.



2-PIECE REUSABLE SWIVEL FEMALE

Increase serviceability of your original equipment with Eastman Reusable Couplings—for rubber and cotton cover hose.
Sizes: 3/16" thru 1 3/16".
Working Pressure: 375-5000 p.s.i.

Eastman
first in the field

MANUFACTURING COMPANY
Dept. PE-5 • MANITOWOC, WISCONSIN

WRITE FOR HIGH PRESSURE CATALOG!
Get on our mailing list to receive our latest Technical Bulletins, Catalogs and Special Inserts.

TO WATCH...

A new gear lubricant . . .

. . . that "gives the best protection known against friction and mechanical trouble," and a new high-performance automatic transmission fluid, "are being readied for the market place," says a report from Phillips Petroleum Co. In addition, the company has, en route to commercialization, two new materials which "approach or duplicate the desirable qualities of natural rubber." One is a butadiene polymer; the other an isoprene compound, of a type now being evaluated by several laboratories.

Can magnesium be protected . . .

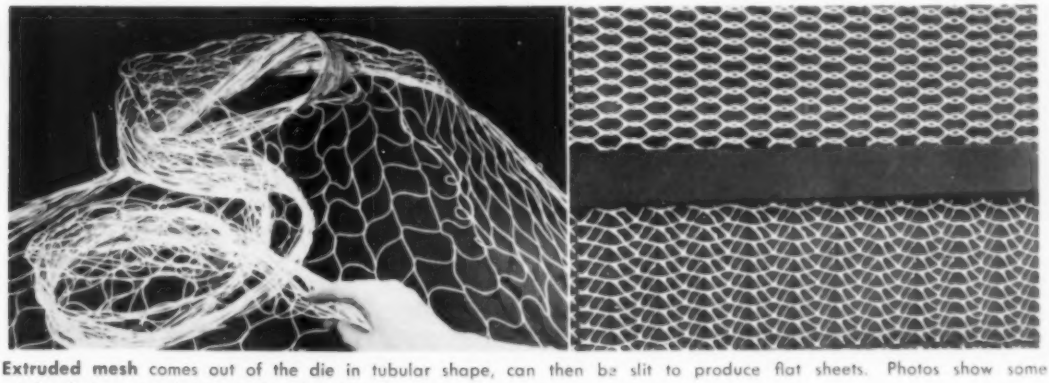
. . . by alloying it with other elements that will migrate to the surface to form a protective coating? Maybe, says the Air Force, and it is sponsoring a research program at Polytechnic Institute of Brooklyn. First reports indicate that a number of elements, all having lower surface tension than magnesium, and therefore likely to migrate to the surface, are worth investigating. Among them: antimony, cadmium germanium, indium, and tin. In the course of the study, incidentally, PIB amassed a great deal of data on surface tension that should be useful in other metallurgical work. It's now available from the Office of Technical Services, Department of Commerce, Washington 25, D. C. (Order *PB* 131444, *Surface Tension Data of Elements*, 51 pp; $1.50.) The magnesium report itself is PB 131443.

Highly effective rust inhibitors . . .

. . . for lubricants can be prepared from byproducts of white oil (petrolatum) manufacture, Frankford Arsenal reports. By fractionating mahogany sulfonates to obtain the fraction of the highest equivalent weight, they obtained a material structurally similar to an alkylated benzene sulfonate with three times the rust-inhibiting effectiveness of the original material. Research in this area is continuing.

Plastic mesh, continuously produced . . .

. . . without heat or solvent is coming from England. It's made by a new and unusual extrusion process that turns out fully formed mesh, the intersecting strands being fused in the die itself. Developed by Plastic Textile Accessories, Ltd., and now in pilot production at Blackburn Pioneer Mill, Ltd., the process offers exciting possibilities. Merely by changing the shape of the die, it should be possible to produce almost any mesh-type design—for air conditioner and radio grilles, filter elements, wire and cable covering, abrasion-resistant surfacing for belt drives, and the like. The photographs below illustrate a few of the design possibilities with nylon, polyethylene, vinyl and rubber filaments.



Extruded mesh comes out of the die in tubular shape, can then be slit to produce flat sheets. Photos show some of the designs now being produced at the Blackburn mill.

DEVELOPMENTS TO WATCH...

Radiation resistance will soon be . . .

. . . as much a part of standard specifications as physical and mechanical properties, if recent new product announcements and exhibits at the IRE and Design Engineering Shows are any indication. Interest of the military in equipment that can withstand nuclear attack, as well as the needs of nuclear reactor builders and radioisotope users are sparking the demand.

Fortunately, many of the materials that are resistant to heat also stand atomic radiation quite well —ceramics, the high-temperature metals, and related materials. Right now, though, there are few real "standards" of radiation resistance; and developing them will take time—particularly since different types of radiation have different effects (neutron beams, in general, are considerably more damaging than isotope or X-radiation). But a good deal of technical data on radiation damage has been accumulated, and several technical society groups are working on the standardization problem (*PE*—Sept. 16, '57, p. 117), so it should not be too long before the design engineer has practical yardsticks.

New dc power supply . . .

. . . gets its first workout in a transistorized unit "suitable for use in computers, aircraft, communication and electronic equipment." The newcomer is GE's *silicon-controlled rectifier*, first announced a few months ago (PE—Feb. 3, '58, p. 17), as a new way to provide precise regulation of power output, and a potential replacement for magnetic amplifiers and power tubes. This first commercial-type unit is rated at 2 to 30 v, 0 to 5 amps, with a regulation of 0.2%. (For more information, see p. 89.)

Dielectric gas that can take 30% to 50% higher voltages . . .

. . . than sulfur hexafluoride in nonuniform fields, has been developed by Du Pont, and is ready for evaluation. An inert, electronegative gas, it is said to have a low solvent power for magnet wire insulation, can be sprayed on transformer coils.

Called *octafluorocyclobutane* or *perfluorocyclobutane*, the new gas is said to be "very stable, even at elevated temperatures," and to perform well under impulse voltages. However, its positive impulse breakdown voltage in a nonuniform field is not as high as the corresponding negative factors. Du Pont notes, therefore, that "the positive impulse breakdown voltages will be the critical values for application to electrical apparatus design."

The new gas is expected to prove useful in evaporative cooling as well as insulation. Du Pont says it boils at 21.1 F, has a vapor pressure of only 25 psi at 70 F.

Titanium gears with a surface durability . . .

. . . "comparable to case-hardened steel" have been produced at Western Gear Corp., Lynwood, Calif., the Air Materiel Command reports. Under AMC contract, Western Gear has also developed a porous-nickel coating for titanium that has "high resistance to wear and good resistance to bending failure by fatigue." The project is so promising, AMC says, that the contract has been extended to cover roll-formed titanium gears. Final report is not expected until July, 1959.

Ultrahigh-resolution cathode-ray tube . . .

. . . that might "provide the missing link in photographic and image transmission systems capable of producing microscopically detailed and accurate pictures with high contrast" is announced by CBS-Hytron. Secret of its precision is said to be the "uniform and microscopically small electron beam which makes it possible to transmit and display images of such fine detail that they far exceed the capabilities of the unaided human eye. CBS-Hytron is now producing a 5-in. tube, but says that "within a year even more compact tubes will be available"—tubes small enough for use in satellites and guided missiles, and capable of operating on miniature and solar batteries.

—ARG

Equation: Good Engineer Equals Bad Executive

LOS ANGELES—"An excellent engineer may be a second-rate, or even a third-rate administrator, and the company that promotes him to a managerial job suffers doubly. Exchanging a good engineer for a poor executive results in decreased efficiency and morale as well as loss of scarce talent."

This broadside at industry's practice of promoting engineers to boss other engineers, to justify salary increases, was fired by Dr. Floyd L. Ruch, President of Psychological Services, Inc., in an interview with PRODUCT ENGINEERING.

He has developed a battery of 10 tests that measure specific mental abilities. After many years of testing large numbers of people this way, he has found that scores earned by successful chief engineers and successful engineers have distinctive patterns (see chart). The specific tests, he says, have proved more successful than general intelligence tests in forecasting ability to handle particular jobs.

On the basis of test experience, Dr. Ruch asserts that industry would use its hired talent best if it separated job compensation—both social and financial—from executive responsibility. Engineering, he stresses, should be viewed by management as a profession with prestige within itself rather than as a stepping stone to management.

The aptitude measured by PSI tests are:

Verbal comprehension—facility for using words in thinking, planning and communicating.

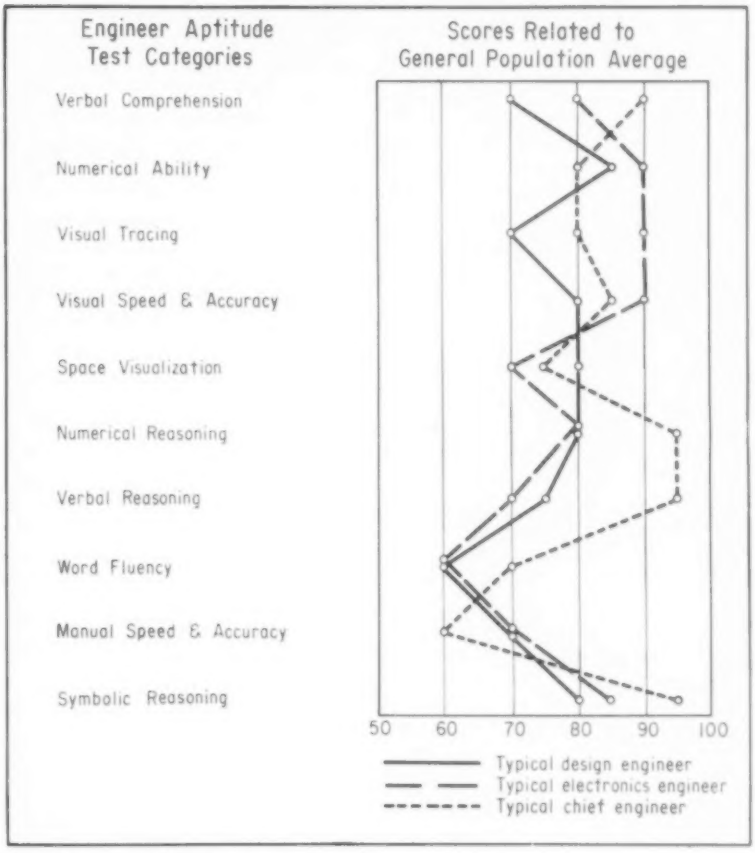
Numerical ability—skill in manipulating numbers and doing arithmetic problems rapidly and accurately.

Visual pursuit—ability to use wiring diagrams, data-flow schematics and similar charts.

Visual speed and accuracy—facility for seeing small details quickly and accurately.

Space visualization—ability to visualize, remember and manipulate space and forms.

Numerical reasoning—thinking number problems through to valid conclusions. This involves manipulation of symbols to discover and apply general principles.



The design engineer . . .

. . . electronics engineer or the engineer with a flair for management each requires special aptitudes to handle his job effectively. Test chart shows by percentiles how the typical man in each category ranks in comparison with 50-average for general population. Tests were developed by Psychological Services, Inc.

Logical reasoning—interpreting and drawing conclusions from verbal statements.

Word fluency—picking the word that best fits a situation.

Manual speed and accuracy—putting dots in the o's printed on a page. (Though apparently simple, PSI psychologists say the test will predict individuals most likely to flunk engineering courses.)

Symbolic reasoning—solving problems that use symbols for "is more than" and "is less than."

Each of the tests can be completed within 10 minutes.

A number of industrial firms, schools, and the US Air Force have cooperated in development of the tests—Lockheed Aircraft has administered them to hundreds of engineers. This company found that it can establish the relative importance of each test for successful completion of any job that can be defined.

High Speed English Diesel

LONDON—Perkins Co. has introduced a small, high-speed diesel for cars and trucks. The 4-cylinder, 320-lb unit has a displacement of 1.6 liters, and the automotive version develops 43 bhp at 4000 rpm. Compression ratio is 20:1. Conversion engine sets are available for $600 to replace gasoline engines in the Ford Consul, Vauxhall Velox, and the Bedford, Austin and Morris vans. Tests show a fuel consumption of 55 mpg.

Mechanization Moves in to

Mechanized Mail-Sorting Reaches Tryout Stage

WASHINGTON—Uncle Sam's Post Office Dept. has contracted for a prototype of a machine designed to sort mail at the rate of 36,000 letters an hour. This is the labor-saver developed by Rainbow Engineering Co. under contract with the National Bureau of Standards, which has undergone tests in its laboratory-prototype form.

The machine ordered by the Post Office will have 1,000 conveyor-carried pockets that will drop letters into appropriate receptacles under direction of a built-in electronic control. The design is modular, so the number of mail categories that can be processed is theoretically unlimited.

If the new machine makes good and is incorporated as standard post office equipment it will climax a long search (*PE*—Apr. 28, p. 75) for an effective way to keep up with the rapid growth in volume of letter mail handled.

Such mechanization involves two problems: perfecting control mechanics of a computer-like device that will sort mail; and integrating this with the small amount of manual handling that mail will still require. Here is how Rainbow met these problems:

An endless conveyor moves a procession of compartmented carriers for letters. Each compartment is a pocket that carries one letter and releases it to drop into a specific fixed receptacle. Electro-mechanical equipment controls the drops. Riding alongside each pocket is a steel rod carrying 12 nylon wheels, each of which can be shifted laterally into one of two positions.

In effect, there are 2^{12} (4096) combinations of wheel positions. As the conveyor moves, each set of wheels rolls over tracks so designed that when the correct "slot" is reached, all 12 wheels drop into depressions. This in turn operates a simple mechanism that causes the accompanying pocket to drop its letter.

The mechanical sorting and coding of letter mail begins at the code printer where letters from a stack of "faced" mail, moved by a conveyor belt, are picked off, one at a time, and mechanically placed in a reading-and-coding position in front of the operator. He reads the addresses, abbreviates their important parts, and types these abbreviations on the back of the envelope a special printer.

APPLICABLE FROM ALL LEVELS

The print coding is in a binary form, requiring six bits for each alphanumeric character. For outgoing mail, the coding operator may merely abbreviate the city and the state. Choice depends on whether all the coding is to be done at the initial location or part of the coding at the final destination. In any case, not more than 64 bits would be required for the entire abbreviated address.

The operator then pushes one of four buttons—local, outgoing, airmail or miscellaneous—and sends the coded letter through its first sorting. The mechanism actuated by the push-button opens a trap door and sets a directing vane so that the coded letter drops into the proper pre-sort release from the code printer.

Requiring only a few seconds per letter, this operation figures to be the only human effort in the entire sorting process. The reading head of the code reader is located in the reader-feeder-inserter mechanism just before the point where the letter is dropped into the conveyor.

ELECTRONIC TIE-IN WITH CONVEYOR

An electronic directory receives the coded, abbreviated address from the code reader, "looks up" the sorting destination for each address and controls delivery of the letter to the appropriate receptacle. Its output drives a mechanism that sets each group of code wheels alongside the conveyor's moving pockets to the appropriate coded arrangement to drop each letter in its proper receptacle—$\frac{1}{10}$th sec is required for entire sequence.

The electronic directory converts the information in the 64-bit code of the abbreviated envelope address into

Coding operation . . .

. . . is only human effort needed with Rabinow-designed machine. Operator types abbreviations of addresses onto the backs of envelopes with code printer. Coding is in binary form, appears in the form of "dot" or "no dot" on envelope.

Mechanical mailman . . .

Here's over-all view of Rabinow Engineering's prototype that can sort mail at the rate of 36,000 letters per hour. Designed for US Post Office Dept., machine moves as many as 1,000 pockets on a conveyor (foreground); electromechanical equipment controls dropping of a letter from pocket into specified receptacle.

Mechanized directory . . .

. . . prepares letters for electromechanical soring process. Obeying prearranged schedule, it converts information in the 64-bit code of the abbreviated address into a 12-bit code corresponding to receptacle which receives the letter.

Speed Sorting the Mails

a 12-bit code corresponding to the slot where the letter is dropped.

The directory consists of a stack of 64 thin plates of stainless steel, each approximately 1 ft sq. Each plate is etched with 40,000 small round holes about 1/30th in. dia and spaced on 1/8th-in. centers. Plates can be moved by an electromagnet from left to right about 1/8 in.

Plates are covered initially with an opaque black ink that fills the holes. Some of these holes are punched out to provide the directory with its address conversion data. Each plate corresponds to a dot position on the binary address code.

HOW WHEELS ARE SET

Some 12 phototubes are located behind these plates, each of which scans an area of 3 to 4 in. of the plate stack, areas that don't overlap. In front of the plates is a source of light that illuminates the entire area. When ink is removed from certain of the holes, light is permitted to reach any desired combination of phototubes to create a function table and convert a 64-bit input into a 12-bit output. This 12-bit output is the control for setting the 12 wheels that accompany each letter into the conveyor.

Etching holes in the plates and then filling them with ink guarantees an accurate position for each final hole so that any set of 64 corresponding holes in the stack will line up. The directory contains about 1.5 million bits. So far, no difficulty with mechanical alightment of holes has been experienced. It has been established that the directory in its present stage of development could service a city of 100,000 to 200,000 pop.

Each letter is inserted by the reader-feeder-inserter into a separate pocket on the conveyor. At the same time, the code wheels for each pocket are set according to the output of the directory so that its letter will be deposited into the proper final-sort receptacle. A setter returns all code wheels to their "zero" position following the letter drop. Empty pockets are then reloaded, and their corresponding code wheels are set for another sort.

Parcels Post Faster Too . . .

PHILADELPHIA—The costliest and most time-consuming problem of railway mailhandling—sorting parcels too large to handle in mail sacks—has been solved by the Pennsylvania Railroad with an electronic system using digital techniques. Developed by the Stewart-Warner Corp., Chicago, the system has been installed in the railroad's Philadelphia terminal.

Besides reducing manual handling and visual sorting by destination, the method moves mail through the terminal by as much as 8 to 12 hours faster. Some of the parcel post is now reaching destination as much as a day earlier.

HOW IT WORKS

The parcels are loaded on the conveyor belt manually. Mounted on the side of the conveyor are a row of lights that appear to move along with the conveyor at 3-ft intervals. They show where packages are to be placed. There are two marking stations. Each marker reads every other parcel and pushes the proper code button on a keyboard. Coding plugs indicate which transfer station is to receive the package. There are 39 such removal points—they feed into shorter roller conveyors at right angles to each side of the main conveyor belt.

The correct code for the passing package is entered into a buffer storage unit so that the operator has only to record parcels in the correct order, and may take longer to record one than another. The parcel then passes an electric eye which signals that a parcel went by and its coded destination was transferred to the main memory.

The decoder at each station is a large "AND" gate which has the coded input of the station and awaits the proper timing pulse for the individual transfer mechanism which removes the parcel. This pulse is required because the transfer mechanisms are not located at direct multiples of the zone length from the starting electric eye.

When the mail sorting is done manually, 15 men are needed to load the parcels onto the belt, mark them for removal at a certain point, and lift them off at these points. Further manual handling is often required also for further destination breakdowns. With the new system, only five men are required. Also, it is now possible to sort mail as soon as it arrives, rather than wait for 25 trucks to accumulate packages before collecting a group of men to work the sorting belt. The two keyboards are rated for 1200 parcels per hour.

Timing for the system is taken from a small wheel which rides on the main conveyor belt. This wheel operates a small pulse generator which operates a one-shot multivibrator: its output is amplified to operate the relay of a stepping switch.

The system was designed to accommodate a belt speed of 60 fpm, but has been operated at 80 fpm. Maximum weight of each package should not exceed 80 lb with this system, but the company states that it is possible to design a system of this type for 500 and 1000 lb.

Stewart-Warner says that the system will pay for itself in 2 to 3 years.

Several other systems being developed by Stewart-Warner have several belts and storage mechanisms which will store parcels or mail bags and feed them into the system at points to keep the system at capacity.

Parade of parcels . . . passes coding station on their way to discharge points which will automatically push them off the conveyor belt on basis of information supplied to decoders. Attendant here pushes desired code button on a keyboard.

Canada Ponders "Yankee Engineer—Go Home" Order

TORONTO—The welcome mat for US engineers here is fast being withdrawn and, if the recession continues, legislation now on the books may be enforced to keep such Americans out.

Two Canadian groups, the Association of Professional Engineers and the Association of Consulting Engineers, are worried by indications that US companies with Canadian subsidiaries are sending semi-surplus engineer staffs to Canada—and firing Canadians to make room.

Says Lt. Col. T. M. Medford, APE executive director, "We feel the situation could become serious if we don't take action to prevent it.

"If we can show that the entrance into Canada of a US engineer is filling a position that a Canadian is competent to do, we can stop him. We've protested to the Department of Immigration about this sort of thing.

"We're also keeping a close watch on licenses bought by foreign-born engineers wishing to practice here. If an engineer doesn't get a license to practice, he must get out of Canada."

Another sore point which may get attention here because of the downturn in business is the duty-free importation into Canada of blueprints and plans. Canadian engineers complain they must pay to take blueprints to the US.

Of the 16,714 registered engineers in Ontario, about 1700 are US citizens. Last year, about 1700 engineers were admitted to the Ontario engineers' Association, 2.8% of whom were from the US. In January, the US percentage was 2.9%, with the Department of Citizenship and Immigration reporting that the number of immigrating US engineers was increasing.

Individual engineers report that there has been a steep increase in US engineers in nearly all branches of the business within the last six months, particularly in construction.

US engineers, they say, are also dominant in the oil and petrochemical industries, and in mining and metallurgy.

One consulting engineer predicted, "With the new Conservative Government in power, duty-free blueprints are on the way out for US engineers."

The existence of the new government, it's predicted by some engineers, also means there'll be early action against the US supplying engineering brains to Canada in jobs that Canadians themselves can fill perfectly competently.

Hospital Profits With Ultrasonic Cleaner

MANHASSET, L. I., N. Y.—"The ultrasonic method of cleaning our surgical instruments has cut time and labor by well over 80%. It does the work of three hand-scrubbing hospital workers and far more thoroughly." These were the words of Dr. G. W. Dana, Dir. of the North Shore Hospital in reporting on a one-year test of this equipment. He added that the bill for replacing broken instruments had gone down.

Soviet forward look . . .

These four car models displayed at Brussels Fair by USSR are distinguished by bright, two-tone colors, something new in Russian styling which up to now has run to black. Note also hooded headlights surrounded by rash of chromium. Upper left: the Yanka, or Seagull, soon to be in production, replaces the famed Zim. Upper right: the Zil III is prototype of heavy limousine for VIP's and replaces the now discarded Ziv 110. Lower left: the Volga, a newcomer to line of USSR light, small cars, is slated for export market. Lower right: the Moscovitch, slightly bigger than Volga, also for the small car market.

Forum Highlights Static Controls

BUFFALO, N. Y.—Over 100 machine-tool manufacturers aired mutual problems April 29 and 30 at the Westinghouse Machine-tool Forum here. The 300-plus tool and component-designers disclosed several trends.

Static controls are favored over vacuum tubes and moveable-contact relays. In fact, several companies indicated they will no longer apply tubes and conventional relays unless there is no other solution.

Motor-drive packages are still experiencing change, and rightly so. Speed control today has as many forms as there are manufacturers, i.e. Rectiflow (new Westinghouse drive), Ajusto-spede (Louis Allis Co.), Varidyne (U.S. Electrical Motors, Inc.), Vairator (GE Co.), and others.

Westinghouse introduced the "Rectiflow" as answer to drives that require more speed control (up to 3:1) than is practical with simple induction motor, yet not as much as given by more complex packages such as Allis-Chalmers' 120:1 thyratron-controlled shell-type dc motor (*PE*—Mar. 31, p. 108). Restiflow drive was developed for grinders, but is applicable to lathes, presses, pumps and blowers. It is essentially two standard-type motors on a single shaft: a wound-rotor induction motor that can be made for 220, 440 or any normal ac supply voltage; and a dc motor wired so that its rotor armature uses only slip current of the ac rotor. Rectifiers change ac to dc for the dc armature and field; sliprings and a commutator carry the current into and out of the rotor windings. A rheostat varies dc field current to control speed.

The induction half cannot rotate faster than 1800 rpm (it is 4-pole); and therefore runaway speeds are not possible. The dc-motor variable field controls speed by inducing back-emf to buck ac rotor currents. This has similar effect to putting resistance in ac rotor circuit, except that power is not lost but apears as dc-motor shaft output. Once set, speed varies only about 7½% from zero to full load, because back-emf tends to oppose change.

Ac motor carries all load at or near 1800 rpm, because slip current is negligible. At ¼ speed (for 3:1 range motor) the dc-motor portion carries about ¾ of total load. Horsepower rating is constant throughout speed range.

Other highlights discussed at forum were proximity switches (static, of course), Cypak timers, 15-amp transistors, and other new or fairly new items.

The recently improved Nul-trax transducer was described by the Canadian engineers who developed it. This device can read-out machine-table position within 0.0004 in. out of 40 ft. It is a linear differential transformer that has two opposed primary windings on a long rod, and similar secondary windings on a short sensing head that slides along the rod. Because of the opposed windings, no net magnetic flux occurs along the rod even when energized. However, flux varies sinusoidally, averaging zero, and the sensing head can detect (within 1 part in 400,000) its relative location between turns. A conventional potentiometer or equivalent is needed to tell just which primary turn the sensing head is near.

During the business portion of the meeting, progress was reported in relaying National Machine Tool Builders Association, JIC, National Electric Code and other standards.

Business VIP's to Weigh R&D as Recession Cure

NEW YORK—The ability of research and development to help industry overcome the present business downturn will be discussed here next Monday at a special Economic Mobilization Conference called by the American Management Association.

According to Lawrence A. Appley, AMA president, more than 1000 of the nation's top business executives are expected to attend and hear leading industrialists describe what measures they're taking to combat the recession.

Pre-conference reports indicate that the channels of sales, marketing and finance as well as R&D will be thoroughly explored to answer US businessmen who have been asking: Should we stand still and ride out the recession, or is there something that can be done about it now?

Bits and Pieces

A magnet-less dc electric motor—designed on the theory that the rotation of solid dielectrics in an electric field is possible in air or other gaseous medium as well as in a liquid—has been developed by Leningrad specialists . . . Red China claims it's will soon be producing solar pumps for irrigation, solar drying, and radiators for heating, according to McGraw-Hill World News in Tokyo . . . With 14,000 employes in its four atomic plants throughout the US, General Electric reports that not one injury from radiation effects has been reported in 11 year – indicating radiation-protection problems aren't insurmountable.

A. V. Bodine, president of the National Machine Tool Builders' Assoc., charges that the US Internal Revenue's depreciation policies applying to machine tools and other productive equipment are "outmoded." . . . A mine detector ¼ the weight of a standard model, equipped with transistors instead of electron tubes, and with increased sensitivity, has been developed by the US Army R&D Labs, Fort Belvoir. . . . A self-contained recording accelerometer equipped with permanent magnets to provide the flux for the recording process, eliminating need for conversion of electrical current, has been announced by Southwest Research Institute.

Metal powder industry at its 14th annual meeting in Philadelphia voted to create the Metal Powder Industries Federation to cover metal powder producers, ferrite manufacturers, metal powder core and powder metallurgy associations. . . Here's a bright note: Boeing Airplane Co. announces its need for more than 1,000 additional engineers because of stepped-up missile and space vehicle assignments. They're interested mostly in electrical and electronics engineers but will take on engineers in related fields. . . . A portable radio capable of operating on 1/10th the current required to drive a conventional auto radio, and said to provide 10 times the undistorted power output, has been reported by Akkord Radio GmbH, Germany.

READER TO EDITOR

Whose Liability Is Poor Design?

To the Editor:

I read with interest Mr. Wulfinghoff's letter on current automobile style trends (Mar. 17, p. 24) and would like to take issue with him in one respect—he was too restrictive. Mr. Wulfinghoff's criticism was only of style. He pointed out that Detroit is forcing "elephants on buyers who are looking for polo ponies and building cars that look like houseboats on wheels."

What about the stuff underneath the hood? Does Detroit design the innards of its cars to last two years and then disintegrate, rain or shine, or may the buyer expect his car to stay together a little longer? What is the moral obligation of the manufacturer (of any product) to guarantee the life of that product? In Detroit apparently no matter how poor the design, the warranty covers only the first few months of the car's life.

Let me illustrate with my own case. I own a 1955 Buick. This winter after 27,000 miles the transmission (Dynaflow) completely burned out and cost $170 to replace. I suppose that the owner of a Buick should be expected to be able to cough up the $170, but my point is that the owner of a car costing over $3,000 (now over $4,500) should not have to budget for this type of expenditure. I spoke to Buick management in the hope that they would recognize their design mistake and back up their product and name. My point was completely ignored. If this were a single case, I would ignore it too; but in my family there are two other Buick owners and the same Dynaflow problem has confronted them all.

It might be of interest to know the nature of the design failure that the Buick people did recognize. In answer to my plea for ethical treatment I was told quite candidly by the company that the trouble was quite normal, that it all resulted because we had a lot of snow this winter, which strained the unit. That's like telling the owner of a convertible that the car is great just as long as he stays out of the rain.

The issue seems plain. Is there or is there not a liabililty upon the auto manufacturer to stand behind the machinery he sells? Must not the manufacturer make good his design botches even if the error does not become evident during the legal guarantee period? I must say to Mr. Wulfinghoff that if I had the choice of having the "houseboat on wheels look" corrected, or of getting a reliable piece of machinery, I would choose the latter.

—Richard A. Pearl
Scarsdale, N. Y.

• Is there any correlation between complaints like Mr. Pearl's, and many other car owners, with the current slump in US auto sales? In a recession, it's interesting that the British Automotive Industry's sales at the recent International Motor Show in New York totaled $12.7 million for 4009 units. Total sales at the show was over $25 million.–Ed.

For the Record

To the Editor:

In your article on dry batteries (Feb 17, p. 72) you stated that "insulation can be tested for breakdown by 34 No. #6 cells (510 v)." Dr. J. J. Coleman, vice-president, engineering, Burgess Battery Co., has informed me that insulation testers use 3 or 4 No. #6 dry cells and a transformer to produce 510 volts. Hope this sets the record straight.

In the same article it stated that "low-power applications are limited." I am sure you meant "unlimited."

—Ronald Goodman
Chicago

• Right you are, our mistake—Ed.

Sticky Problem Solved

To the Editor:

Would that all of our problems could be answered as easily as that posed by E. J. Hills, who requested a floor tile with an adhesive on the back (*PE*—Apr. 7, p. 50). The product Mr. Hills would like to see not only exists but appears in an even more refined shape than he described.

Back about a year ago, our company developed and released for general marketing a pressure-sensitive adhesive furnished in the form of a film that is tacky on both sides, yet "dry" and ready to use—as contrasted with a conventional semiliquid formulation. One of the earliest uses for this adhesive in dry-film form was as a backing material on vinyl tiles which could then be installed merely by pulling off the release paper, placing the tile in position, and stepping on it.

No heat is required at all.—Next problem?

—Bernard Gould
Rubber and Asbestos Corp.

Nero Was the Fiddler

To the Editor:

I have just read your March 31 issue of Product Engineering with its special report, "The Engineer Comes into His Own." May I offer my congratulations on this fine presentation.

Just one item should be corrected, and that in "Interesting to Note" (p. 7). It was, of course, Captain Nemo who piloted Jules Verne's "Nautilus," not Captain Nero.

—Ariel G. Schrodt
Director, Detector Development Dept.
Nuclear-Chicago Corp.

• *Thanks to Mr. D. E. Hildebrandt, Parkersburg, W. Va. who also caught our mistake—Ed.*

Not New

To the Editor:

I'm afraid that the "English Engineering Psychologist" who developed the "Micrometer with Digital Readout" (March 31, p. 99) is slightly behind the times. I had a 1" and a 2" mike with "digital readout," (sounds real fancy for numbers) in the 1920s; they were made by the Central Tool Co. The L. S. Starrett Co. also made a mike with numbers for many years. It was discontinued about 1940. Apparently they didn't sell too well.

—J. H. Sperman
Sperman Metal Specialties
Brooklyn, N. Y.

• Brown & Sharp Mfg. Co., Providence, R. I. also believe there is a market. They announced one at the ASTE Tool Show, May 1-8 in Philadelphia.–Ed.

so quiet...

Just one of the reasons these electric motor manufacturers use Hoover Quality Ball Bearings

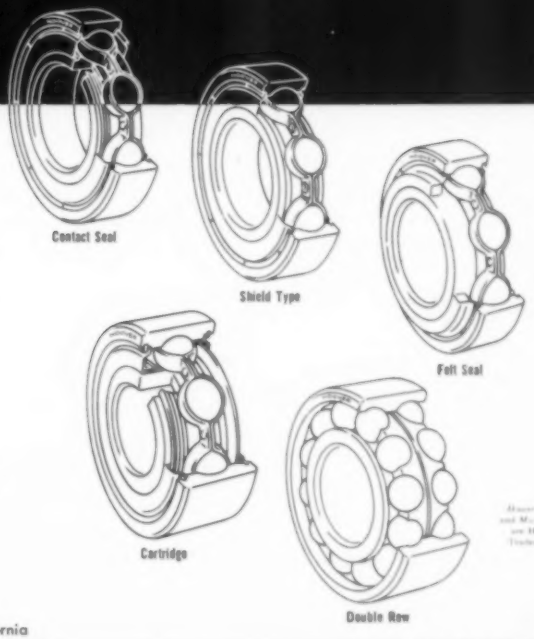
Allis-Chalmers Manufacturing Company
The Louis Allis Co.
Baldor Electric Company
The Brown-Brockmeyer Company
Century Electric Company
Cleveland Electric Motor Company
Continental Electric Co., Inc.
Diehl Manufacturing Co.
Doerr Electric Corporation
Electro Dynamic
Electric Machinery Mfg. Co.
Elliott Company
Emerald Motor & Mfg. Co.
Emerson Electric Mfg. Co.
Fairbanks, Morse & Co.
General Electric Company
Howell Electric Motors Company
The Ideal Electric and Manufacturing Company
The Imperial Electric Company
Iron Fireman Manufacturing Co.
Jack & Heintz Inc.
Kingston Conley Incorporated
The Leland Electric Co.

The Lima Electric Motor Co., Inc.
The Lincoln Electric Company
Marathon Electric Manufacturing Corporation
Marble-Card Electric Corporation
The Master Electric Company
Oak Electric Motors, Inc.
Packard Electric Division
The Peerless Electric Company
The Piqua Machine & Manufacturing Co.
The Reliance Electric & Engineering Company
Robbins & Myers, Inc.
Reuland Electric Company
The Springfield Electric Motor Co.
Star Kimble
Sterling Electric Motors, Inc.
Valley Electric Corporation
Wagner Electric Corporation
The B. A. Wesche Electric Company
Bogue Electric of Canada, Ltd.
American Electric Motors
A. O. Smith Corporation
Oster Manufacturing Company
Dayton Electric Service Co.

Constantly sought by manufacturers and users is velvet smooth operation of electric motors that whispers "*superb quality.*"

In many leading makes of motors, as well as other products, hushed quietness is assured through the use of Hoover Quality Ball Bearings. Precision made with super smooth *Hoover Honed* Raceways and perfectly matched *Micro-Velvet* Balls, Hoover Ball Bearings are exceptionally quiet, exceptionally dependable, exceptionally long lived.

You, too, can put these Hoover advantages to work . . . in the products you build, in the equipment you operate.



hoover

BALL AND BEARING COMPANY
ANN ARBOR, MICHIGAN

Los Angeles Sales Office and Warehouse: 2020 South Figueroa, Los Angeles 7, California

Please send the literature checked:

Bulletin 100—Lubricated-for-life ball bearings with seals of TEFLON*.

Hoover Handi-Book of Anti-Friction Bearings which outlines bearing types, problems, applications.

Bulletin 101—Hoover *Micro-Velvet* Balls of chrome steel, stainless steel, brass, bronze, monel.

*TEFLON is a Du Pont Trademark.

Bulletin 100

Handi-Book

Bulletin 101

Hoover Ball and Bearing Company
Ann Arbor, Michigan

Name_____
Title_____
Company_____
Address_____
City_____ State_____

ARE ALUMINUM COLD FORGINGS ECONOMICAL ONLY ON COMPLEX DESIGNS?

Nipple, nut and socket of Aeroquip Detachable and Reusable Fittings for flexible hose lines currently used in piston and jet aircraft plumbing. Four sizes from 1" through 2" are available.

The answer is NO! Here's a typical product relatively simple in design and with no unusual production problems. Originally turned from solid bar stock, the components were later made from hot forgings.

With a wide-awake eye to costs, Aeroquip management investigated Hunter Douglas aluminum cold forgings. Now completely cold forged from 2014-T6 aluminum alloy, these components not only prove more economical dollar-wise, but have eliminated a costly inventory problem! Shipments are now met promptly *with less money tied up in stock* because of Hunter Douglas' ample production capacity and rapid delivery schedules. In addition, product quality with the aluminum cold forgings has noticeably improved.

Get full details on Hunter Douglas Aluminum Cold Forgings

If your components can benefit by *high strength, precision tolerances, absence of porosity, zero draft* and *improved surface finishes*, investigate Hunted Douglas Aluminum Cold Forgings! A comprehensive treatise is available to letterhead requests. Write for "The Story Of Aluminum Cold Forgings."

Hunter Douglas HD Aluminum

DIVISION OF BRIDGEPORT BRASS COMPANY • Dept. PE-5 3016 Kansas Avenue, Riverside, California

Square D Vertical Action Magnetic Starters Sizes 0, 1, 2, 3, 4 and 5

ONLY SQUARE D GIVES ALL 5

—That's Why You Give Your Customers an Important "Plus" When You Specify Square D Starters

1 *QUICK* INSTALLATION!

No groping or fumbling. Square D provides lots of wiring space, plenty of knockouts, handy and clearly marked pressure wire connectors.

2 *TOP* PERFORMANCE!

No needless downtime from coil burnout, mechanical binding, contact freezing. Square D provides an extra-capacity magnet with a tough and cool-operating encapsulated coil to handle additional poles and interlocks—a guided single moving part—big silver cadmium-oxide contacts with strong finger springs—arcing yokes on larger sizes.

3 *REAL* OVERLOAD PROTECTION!

No change in trip characteristics because of mismatched parts supplied separately for field assembly, no distortion of heater in installation. Square D provides melting alloy unit construction—factory-assembled and individually tested for bull's-eye accuracy. Also bi-metal and magnetic designs for automatic reset or adjustable trip applications.

4 *EASY* INSPECTION and MAINTENANCE!

No starter is "maintenance-free." But Square D makes the job easy. Inspection is a breeze. No need to remove wiring for contact replacement or take the starter out of the enclosure to change coils.

5 *WIDE-RANGE* ADAPTABILITY!

No need for excessive inventories to avoid costly waiting for non-standard arrangements. Square D provides "off-the-shelf" kits for changing contacts and coils, adding pushbuttons, selector switches, and up to 4 double-throw auxiliary circuits.

Send for the COMPLETE Story!

Square D Company, Dept. 41,
4041 North Richards Street, Milwaukee 12, Wisconsin

Please send me your new bulletin with detailed proof that Square D offers me my best starter investment.

Name_____

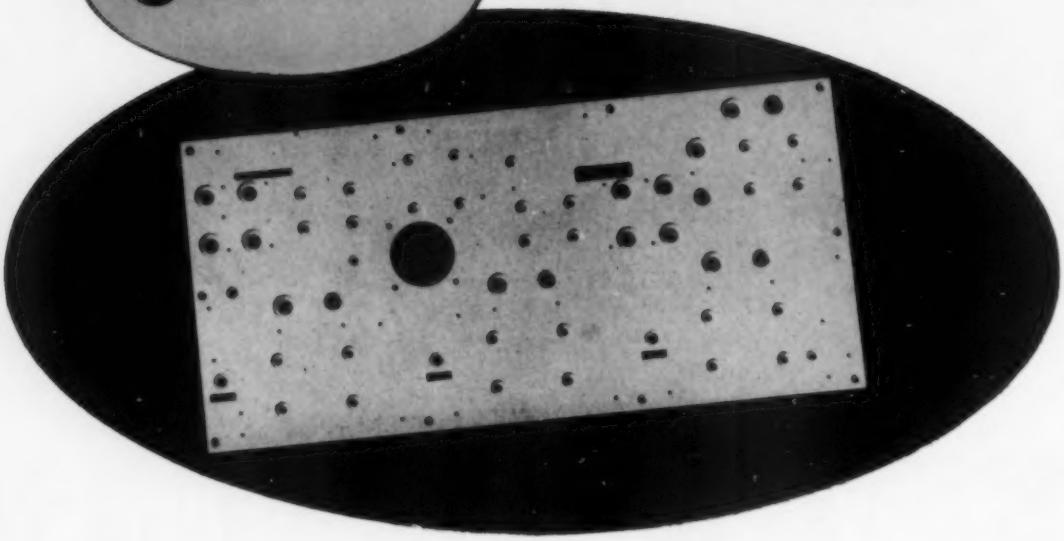
Company_____

Address_____

City_____ Zone____ State_____

SQUARE D COMPANY

Spauldite G5-766



Maintains high arc resistance at 300°F operating temperatures

Spaulding's G5-766 Glass Melamine Spauldite provides the properties needed for applications requiring high arc resistance, mechanical strength, hardness and fine machining. Spauldite is recommended for switch and circuit breaker insulation, as well as for applications where severe mechanical stresses are encountered.

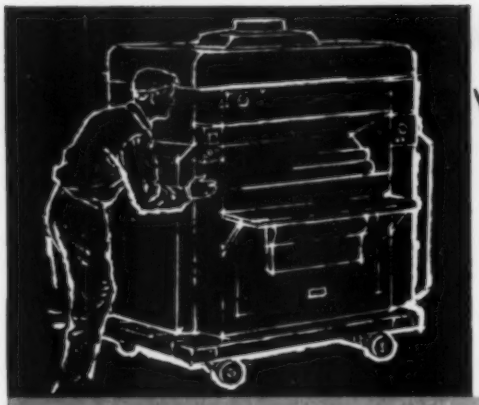
SPAULDITE G5-766			
PROPERTIES		CONDITION	⅛" THICK
Arc Resistance		D-48/50	183 sec.
Dielectric Breakdown Parallel to plies Step by step		 A D-48/50	 over 50 KV over 50 KV
Dielectric Strength Perpendicular to plies Short time Step by step		 A	 over 400 V/M over 400 V/M
Water Absorption			.48%
Specific Gravity			1.95
Flex. Strength PSI	WG AG	A	57,000 49,000
Izod Impact Ft. Lbs./In.	WG AG	E-48/50	10.8 8.6

Spauldite G5-766 is available in sheets, rods, tubes and fabricated parts.
For more information, contact:

SPAULDING FIBRE COMPANY, INC.

308 Wheeler Street Tonawanda, New York

28 Offices in Principal Cities



GOOD BYE: CLUNKER!

GOOD BUY: COPYFLEX!

■ Say good bye to aggravations and increasing costs for downtime and repairs for older reproduction equipment! Modern Copyflex gives you better results, faster, with less operator effort... pays for itself in no time at all!

Take Copyflex Model 575, shown here. With this advanced machine, you can boost your average operating speeds up to 250%. It offers a super-fast mechanical speed of up to 75 f.p.m. and a wide 46-inch printing width. The powerful two-stage exposure lamp can be operated at either 7,500 watts or 5,000 watts with a flick of a switch. A host of time-saving conveniences include: one-knob speed control with perfect automatic synchronization of print exposure and development, automatic separation of exposed prints from originals, automatic stacking of tracings and prints, front or rear delivery.

The Model 575 — like all Copyflex machines — gives you problem-free installations and operation. No exhaust venting, no plumbing, no auxiliary equipment.

Every day you put up with old, inefficient reproduction equipment is costing you time and money. Mail coupon below and find how Copyflex can save you money and manhours.

SEND FOR YOUR FREE COPIES!

BRUNING Copyflex

Charles Bruning Company, Inc., Dept. 53-O
1800 Central Road, Mount Prospect, Ill.
Offices in Principal U.S. Cities
In Canada: 105 Church Street, Toronto 1, Ont.

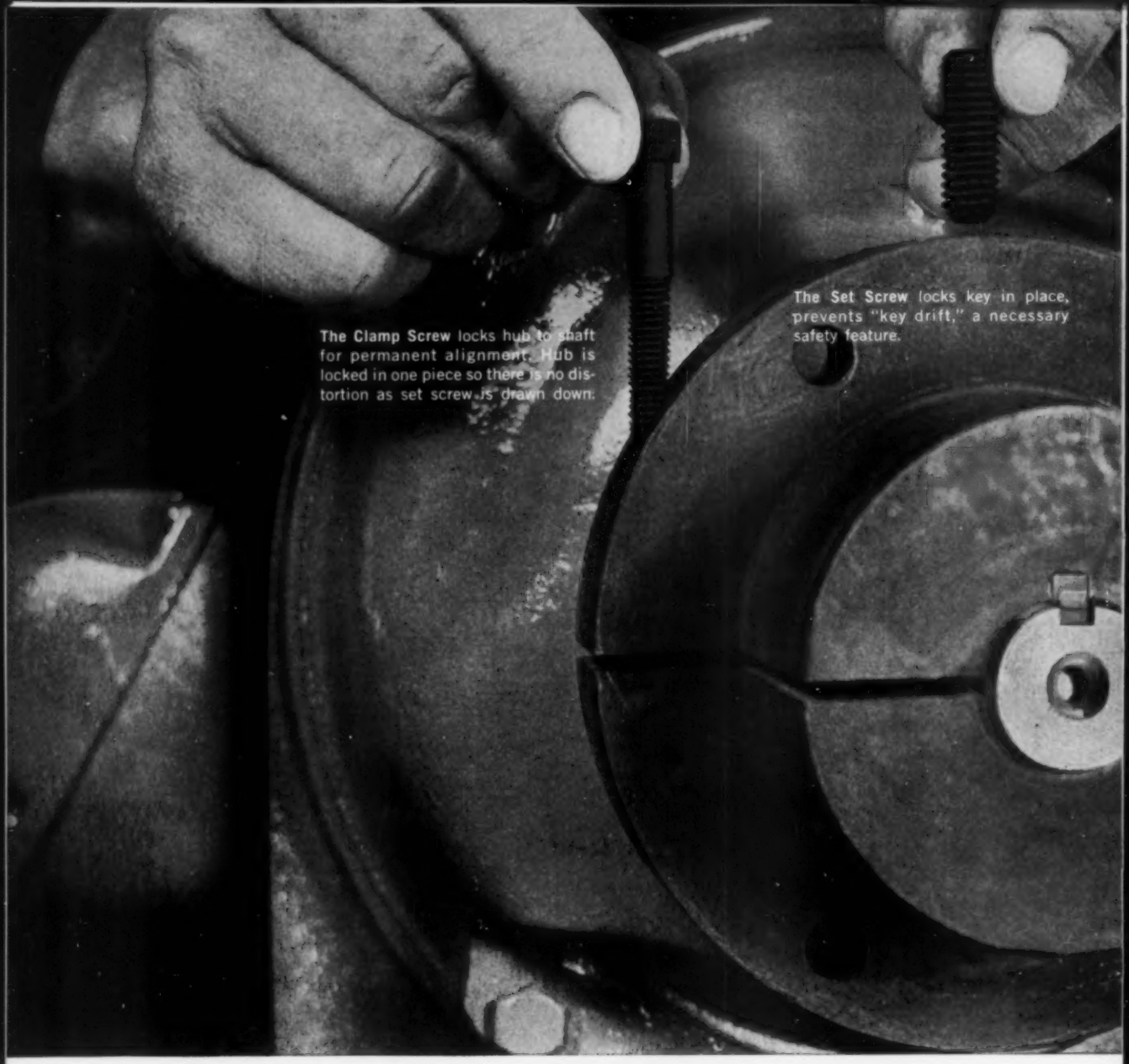
Please send me the booklets on Copyflex Model 575 and Copyflex process and machines.

Name_____ Title_____

Company_____

Address_____

City_____ County_____ State_____


The Clamp Screw locks hub to shaft for permanent alignment. Hub is locked in one piece so there is no distortion as set screw is drawn down.
The Set Screw locks key in place, prevents "key drift," a necessary safety feature.

In Worthington QD Sheaves these extra

2 SCREWS MAKE

Exclusive features of Worthington QD Sheaves...

EASY ON! Two-piece design lets you install the sheave *one part at a time*. No heavy rim and hub combination to inch into place; the tapered hub slides easily on the shaft, is locked by the clamp screw for permanent alignment. The set screw locks key. Then the sheave rim slides easily into position on the taper-seat of hub because the large end of taper in sheave starts engagement with small end of taper on hub. Heavy hex-head bolts complete the assembly.

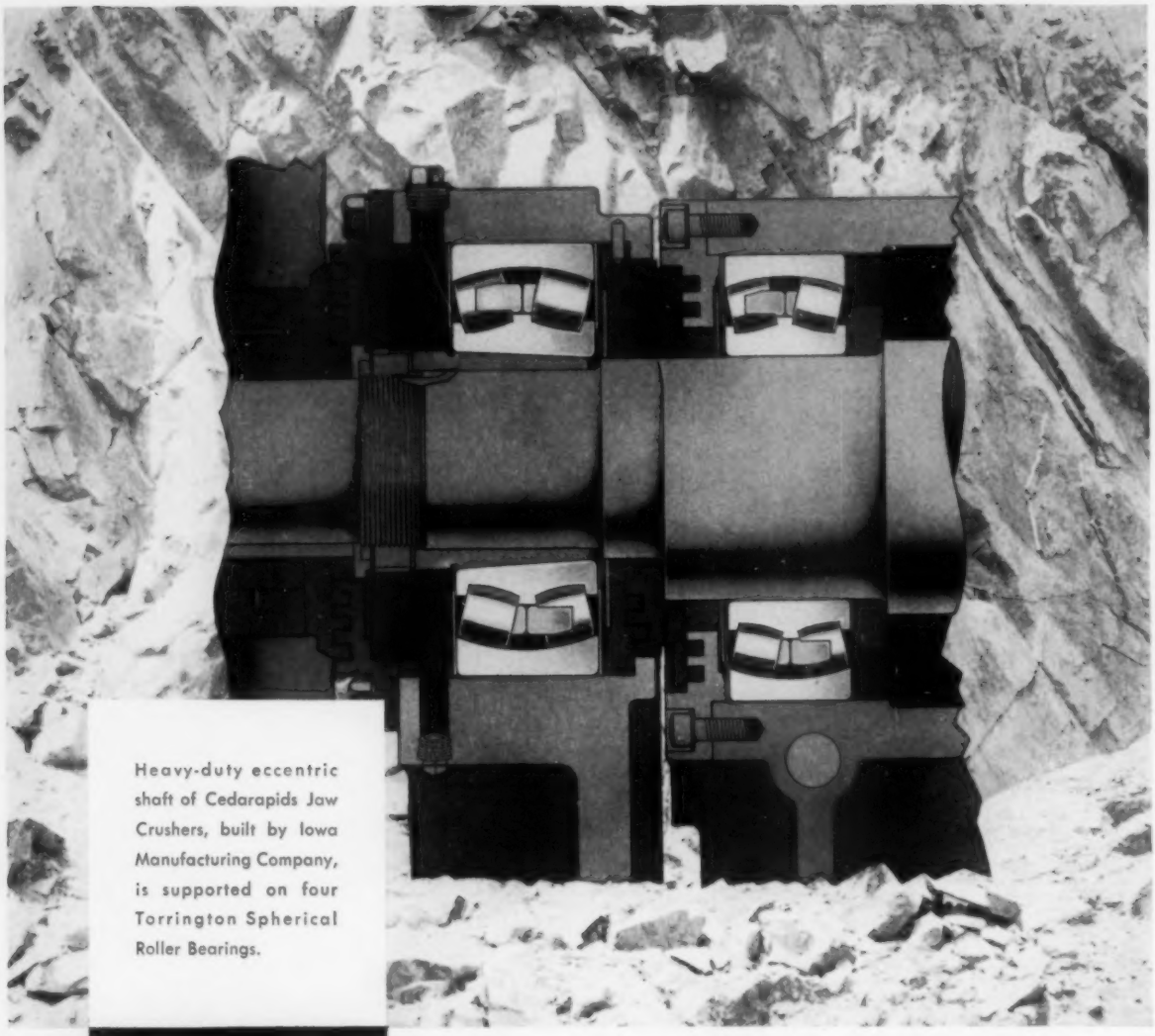
EASY OFF! Remove the big pull-up bolts and use two as jack bolts for easy rim removal. To change speed it's simple to mount a larger or smaller sheave on the hub which, because of clamp screw, remains aligned on shaft. You can install or remove one part at a time.

THE DIFFERENCE

ALWAYS TIGHT! Severe shock or reversing loads cannot loosen the sheave. Tightening the pull-up bolts locks the split-tapered hub to the shaft as tight as if the sheaves were integrally cast with shaft. The set screw anchors the key in position.

COMPLETE STOCK! You can get Worthington QD sheave stock service anywhere in the U. S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For 100 page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Section 79-9, Worthington Corporation, Harrison, New Jersey.

WORTHINGTON



Heavy-duty eccentric shaft of Cedarapids Jaw Crushers, built by Iowa Manufacturing Company, is supported on four Torrington Spherical Roller Bearings.

Designed for tough service

Cedarapids Jaw Crushers are designed throughout for tough, day-in, day-out service, right down to the bearings used on the eccentric shaft.

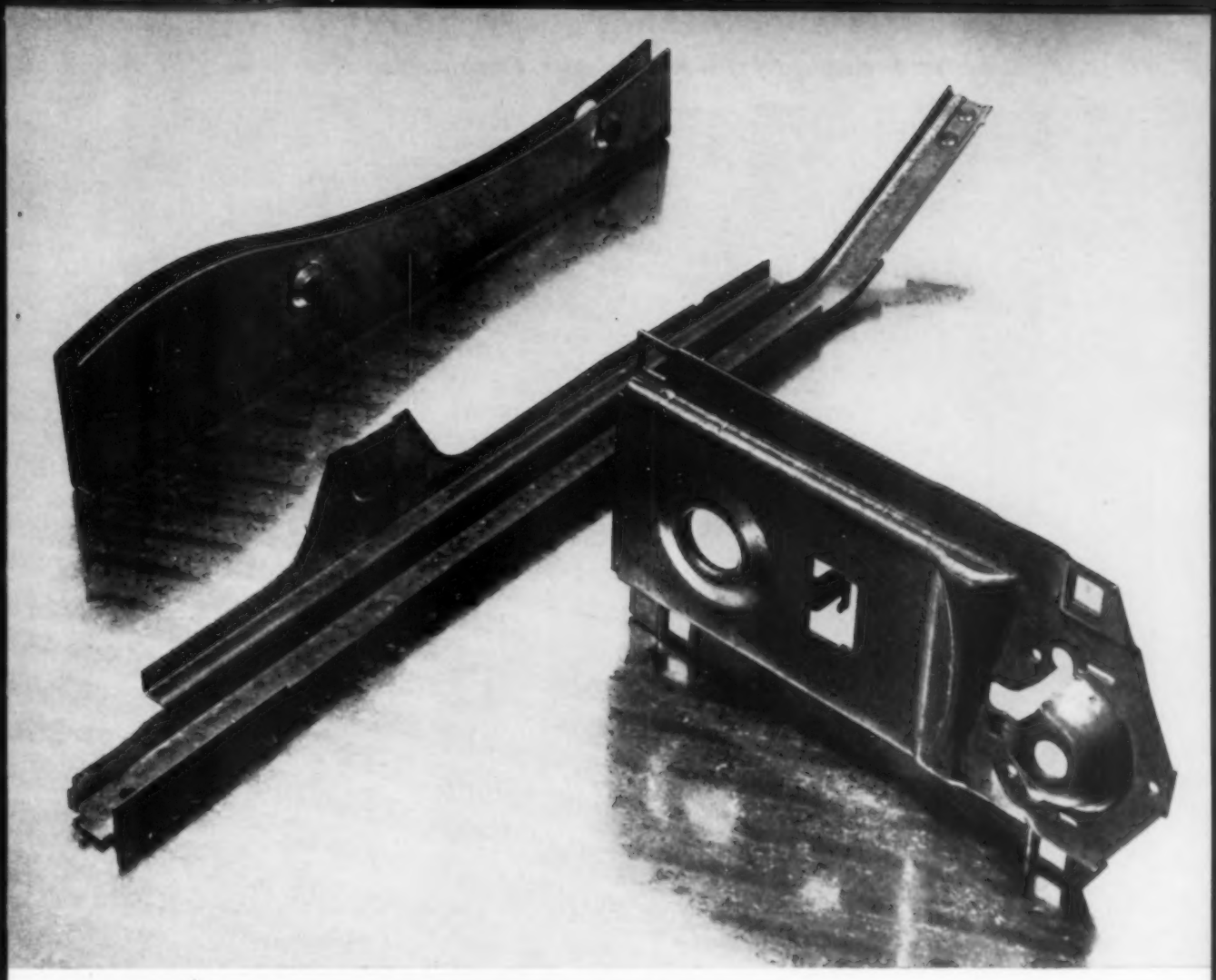
Torrington Spherical Roller Bearings are used because of their ability to align under load, rugged construction, stamina and stability. These bearings provide high radial and thrust capacity—more than enough to withstand the severest loads and shocks the jaw crushers can deliver in hard service.

Torrington Spherical Roller Bearings also are used in Cedarapids roll crushers, hammermills and impact breakers—and in many other construction equipment applications. For your toughest jobs, rely on Torrington Bearings and Torrington engineering experience. **The Torrington Company, South Bend 21, Ind. and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST



WHEN WEIRKOTE GOES ON THE JOB, PLATING OPERATIONS CAN GO OUT THE WINDOW.

THE PROBLEM: The close channel walls and variable stages of these steel frame parts defied economical, uniform, flawless plating.

THE SOLUTION: The manufacturer switched to Weirkote zinc-coated steel sheets. Result—uniform anti-corrosion protection for his parts, which means that the manufacturer may eliminate post-fabrication plating. Weirkote's continuous-process integrates the zinc and the steel. Even though you work Weirkote to the limit of the steel itself, it just won't flake or peel. It gives first-class protection against corrosion, eliminating inventory losses which might occur in the factory. And it gives first-class protection when out doing its work for your product.

And now, Weirkote is treated to inhibit wet storage (white oxide) stain.

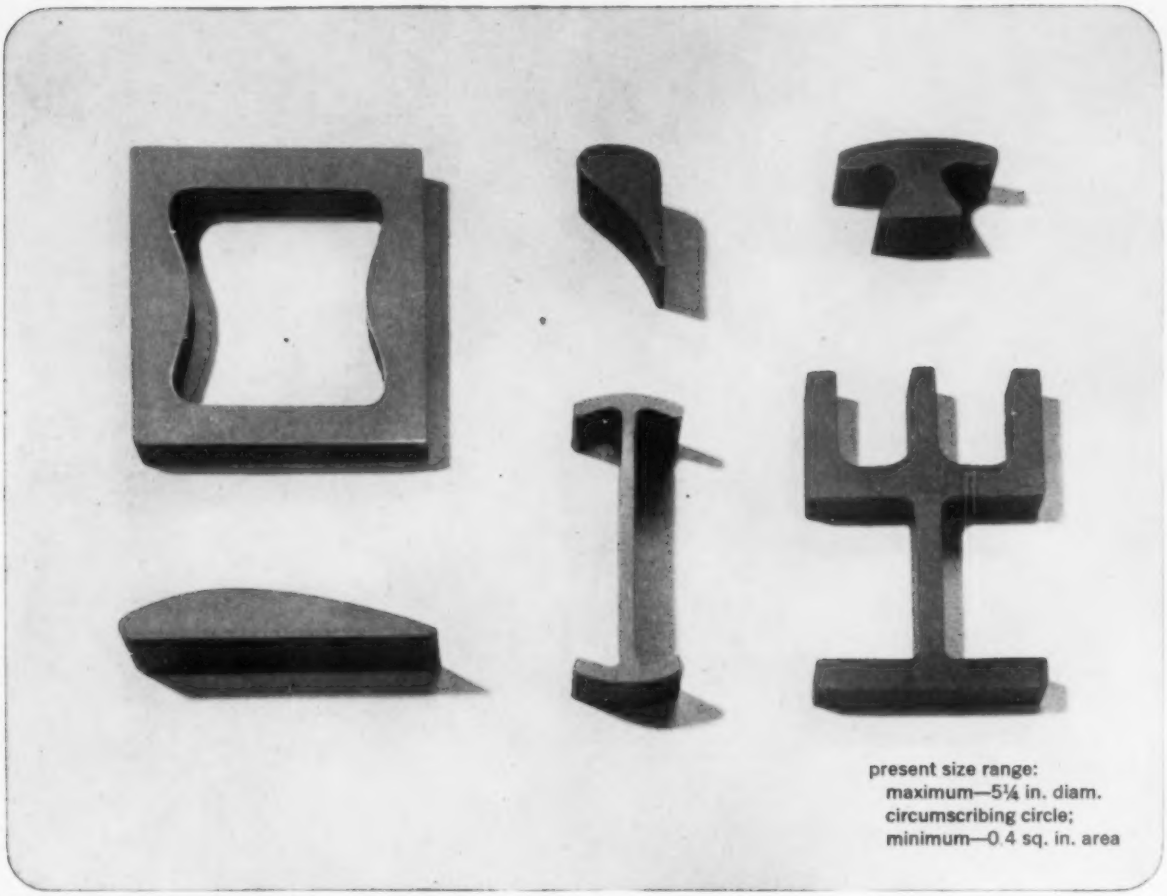
Look into Weirkote zinc-coated steel sheets and the many cost savings and product advantages it can lay on your doorstep. Write for free brochure today. Weirton Steel Company, Dept. D, Weirton, West Virginia.

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

a division of

NATIONAL STEEL CORPORATION



present size range:
maximum—5¼ in. diam. circumscribing circle;
minimum—0.4 sq. in. area

- 321 Stainless
- 410 Stainless
- 405 Stainless
- SAE 1020
- 304 Stainless
- SAE 4340

Here's how highly intricate steel extrusions from Allegheny Ludlum help you cut costs

Allegheny Ludlum Extrusions can help you cut costs, save money. If you are now rolling, casting or machining steel parts like these, consider the cost-cutting features inherent in extruding metal, already proved by non-ferrous extrusions during the last 10 years.

A-L high-quality Steel Extrusions can save you money on four very important counts. (1) Orders are taken in quantities as small as 40 pounds. No large tonnage rolling requirements. (2) Charge for die design is low—under $200. No expensive rolls to cut. (3) Machining costs are slashed to a minimum; there's no waste of material. (4) Extruding saves time from the order to availability of finished parts.

There is no limit to what steels can be extruded. Allegheny Ludlum works everything from all stainless grades to carbon and electrical steels, high temperature alloys, nickel alloys and even metals such as zirconium.

Prove to yourself that extruding steel can save you money. Write for Allegheny Ludlum's 12-page technical bulletin, full of process explanations, material properties, design tips, etc. Or contact your nearest A-L office for technical assistance.

Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pennsylvania. Address Dept. PE-5.

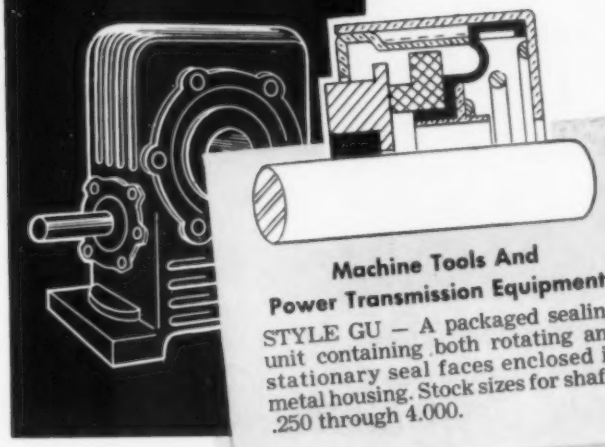
WSW 7120

ALLEGHENY LUDLUM

for warehouse delivery of Allegheny Stainless, call RYERSON

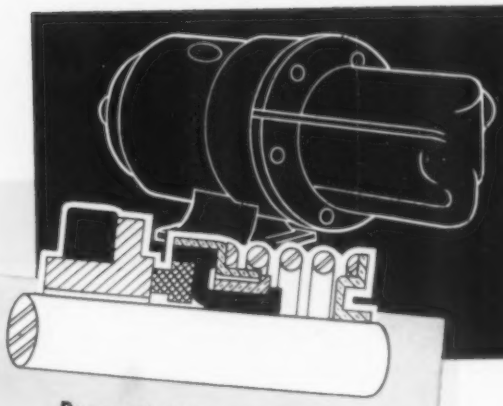
Export distribution: AIRCO INTERNATIONAL

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT



Machine Tools And Power Transmission Equipment

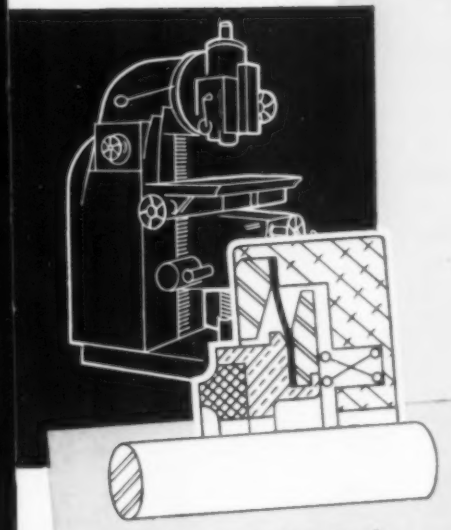
STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.



Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

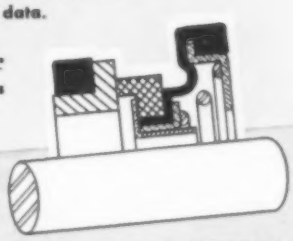
A Complete Line
GITS SHAFT SEALS
For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

GITS BROS. MFG. CO.

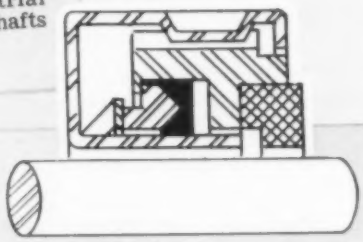
1866 South Kilbourn Avenue • Chicago 23, Illinois

Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



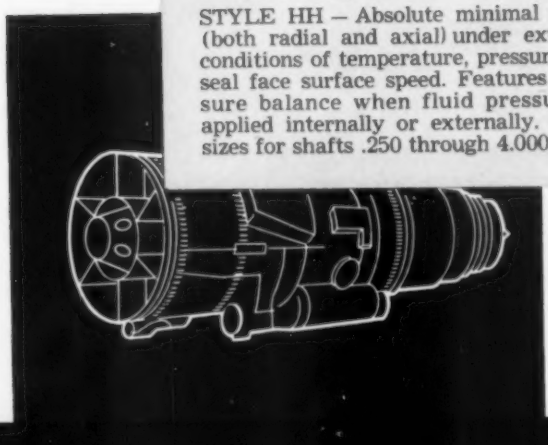
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.



Aircraft Engines And Accessories

STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



Maytag production men find ***P-K® fasteners*** *have* ***BUILT-IN SAFETY FACTOR*** *that helps save time and money!*

"Head breakage can be a major production problem, especially when it occurs in 'blind-hole' assemblies. In such cases the washer or dryer must be pulled off the line while the broken screw is drilled and removed. Salvage operations are even more costly if screw heads pop off after a unit is crated for shipment. So the toughness and breakage-resistance of fasteners can be mighty important.

"Parker-Kalon Self-tapping Screws are well engineered—hard and dependable even with high-torque, impact-type drivers. They give us the safety factor Maytag's high-quality standards demand."

Thousands of users have found P-K's "built-in" safety factor... the extra-ability to withstand highest torque without breakage... helps end annoying slowdowns, excessive rejects, assures rugged dependable fastenings in the plant—in shipment—and in the field. P-K Self-tapping Screws are available in a wide variety of types, sizes and head styles for use in steel, nonferrous metals, compositions, wood, plastic and many other applications.

PARKER-KALON®
fasteners

Sold everywhere through leading Industrial Supply Distributors.

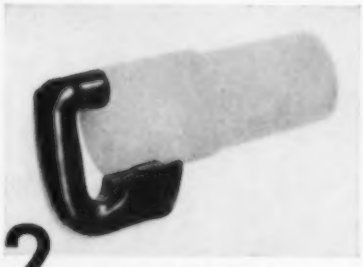
PARKER-KALON DIVISION, General American Transportation Corporation, Clifton, New Jersey. Manufacturers of Self-tapping Screws, Socket Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws.

Six Standard Design Problems . . .

and how to solve them with URETHANE rubber

1. Production Cost:

Hard-wearing urethane rubber is easily cast; requires no post-finishing. *Example:* A cast urethane rubber pin and ball joint replaced machined steel in this gear shift linkage part, reducing finished-piece cost of assembly by *80 per cent!* Other advantages: Self-lubricating, vibration dampening.



2. Vibration Dampening:

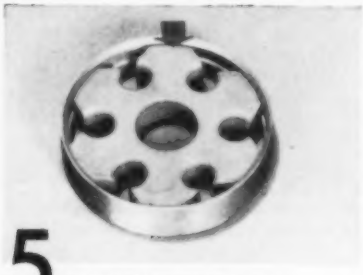
Dimensional stability and high durometer hardness make urethane rubber an ideal choice for parts subjected to shock, impact and vibration. *Example:* Handle for pneumatic hammer reduces operator fatigue and injury risk; improves guidance control. Other benefits: non-slip grip and wearability.

3. Maintenance Cost:

Urethane rubber is grease and oil resistant. Self-lubricating properties may be imparted, cutting maintenance costs on heavy equipment by as much as one-third. *Example:* Socket and coupling for heavy-duty ball-joint assembly. Other benefits: Lower assembly cost, no machining, vibration dampening.

4. Noise Reduction:

Urethane rubber parts cushion while they work; completely eliminate gear noise. *Example:* Sprocket gear for a chain-driven motor bike silenced chain whine, showed no significant wear after 62,000 miles of operation. Other benefits: Lowers chain wear, maintenance costs.



5. Misalignment Stress:

Elasticity of urethane rubber permits up to 0.040 inches linear and 12° angular misalignment without malfunction of meshed parts. *Example:* This urethane rubber drive coupling replaces a laminated metal unit; has sufficient strength to transmit high horse power in rapid stop-and-go operation.

6. Abrasion Resistance:

Very high abrasion resistance enables urethane rubber to outwear ordinary rubbers by 8 to 10 times, and even steel parts in some uses. *Example:* This cast urethane rubber nozzle for sand blasting equipment replaces an all-metal nozzle; wears longer, weighs and costs less.

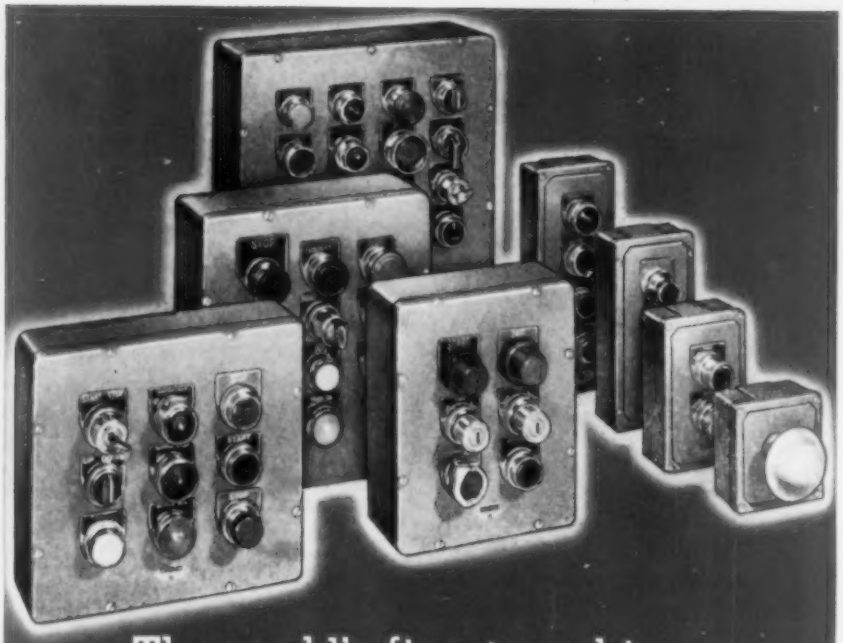
Other design problems requiring special properties of hardness; tensile, elongation and tear strength; rebound elasticity, high and low temperature strength, solvent and oxygen resistance, good electrical and mechanical properties, are being solved with urethane rubber. Write today for technical data, test studies and sources of fabricating assistance.

MOBAY

First in Urethane Chemistry

Mobay supplies basic chemicals and technology required for the manufacture of urethane rubber—latest addition to the growing list of urethane products for industry.

MOBAY CHEMICAL COMPANY
Dept. P-8
1815 Washington Road
Pittsburgh 34, Pa.



The world's finest machines are controlled from Cutler-Hammer oil-tight pushbutton Control Stations

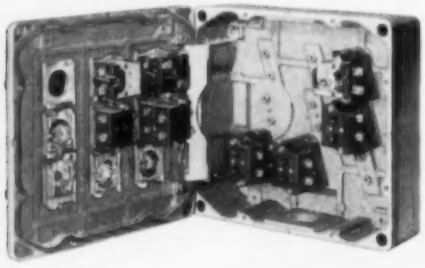
The Cutler-Hammer line of heavy duty oil-tight pushbuttons and precision die-cast control stations surpass anything ever before available to serve the needs of machine design engineers. Cutler-Hammer Oil-Tight Control Stations are precision die-castings to permit both base and one-hole mounting of the control units. The one to four element control stations are available in either the normal depth or the exclusive shallow depth for use where space limitations are critical.

Cutler-Hammer Pushbutton contact blocks are easily tandem mounted without special adapters, and use less behind-the-panel space than any other. Circuits can be arranged in any combination of NO and NC contacts.

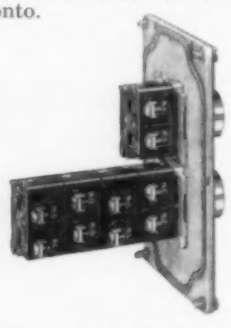
Indicating lights come in a wide selection of colors with either plastic or glass lenses. Among the many special operators are: Roto-Push*, the combination pushbutton-selector switch; PresTest*, the self-testing indicating light; knob, key, lever, and coin type selector switches; flush, long, mushroom head, guarded, and palm type pushbutton operators.

For further information, write on your company letterhead for the C-H Master Design, Publication EL-178.

. . . CUTLER-HAMMER Inc., 1332 St. Paul Ave., Milwaukee 1, Wis. Associate: Canadian Cutler-Hammer Ltd., Toronto.

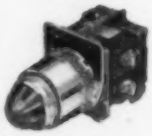


The hinged cover on the larger Oil-Tight Control Stations facilitates assembly and alterations. Precision die-castings permit both base and one-hole mounting of the control units. Raised edge on the box mates with the neoprene-cork cover gasket for a perfect seal.



Complete line of cover plates for cavity mounting. Compact contact blocks take 40% less space behind the panel than the next smaller element . . . additional blocks easily tandem mounted . . . from 2 to 8 separate circuits in any combination of NO or NC contacts.

Special Purpose Operators and Accessories



PresTest—the self-testing indicating light

Guarded mushroom head operator

Neoprene protective boot for flush or long button operators

Indicating lights, six colors available with plastic or glass lenses

Roto-Push—the one button control station . . . with or without lever ring in a deep precision die-cast enclosure

Selector switches—knob, lever, key, coin

CUTLER-HAMMER
MOTOR CONTROL
C-H

MOLY NEWS

CLIMAX MOLYBDENUM • DIVISION OF AMERICAN METAL CLIMAX, INC.

Climax Develops an Extremely Tough, Abrasion-resistant Chrome-Moly White Iron

New Alloy Proves Superior in Erosive Applications

A new martensitic white iron has proved exceptionally tough and resistant to abrasion. It's called Alloy 42. Its excellent combination of properties are related to its structure — which consists of hard chrome-moly carbides favorably distributed in a matrix of martensite plus retained austenite.

Tests indicate Alloy 42 is especially economical for parts subject to erosive wear: sand pumps, flotation impellers, sand classifier wear shoes, pug mill blades, brick mold liners and chute liners.

For example, heat-treated Alloy 42 impellers in a 5" sand pump handling coarsely ground taconite ore have already lasted over 1,000 hours. Previous impellers made of a 4.5% Ni, 1.5% Cr type of martensitic iron lasted only 350 to 400 hours.

Because of its toughness, Alloy 42 can also be used where moderate impacts would cause low alloy types of white iron to break or spall. And it may prove more economical than the soft rubber parts or linings now used in various abrasive applications. Its resistance to tearing by tramp coarse materials and chemical attacks by oils and other organic compounds is an obvious advantage.

The recommended composition range is: Carbon 3.00-3.50%; Silicon 0.30-0.60; Manganese 0.60-0.90; Chromium 15.0-18.0; Molybdenum 2.75-3.25.

A Climax bulletin on Alloy 42 discusses melting and casting, molds and shrinkage, heat treatment, structure, physical properties, machinability, welding and cutting. *For a free copy, circle #1 on the coupon.*

Heat Treating Improves the Wear Resistance of Gray Iron

Heat treating can improve many of the properties of gray iron, particularly resistance to wear. Wear resistance in quenched-and-tempered gray iron is many times greater than that of pearlitic irons. With cams and similar parts, hot quenching provides better wear resistance than quenching and hardening to the same hardness. Surface hardening is frequently selected for gray iron because it locally improves wear resistance with minimum distortion.

Why Moly Iron Bulletin #6 contains valuable information on surface hardening, annealing and stress-relieving molybdenum-alloyed irons. This bulletin gives examples of improvements obtained by heat treating gears, cable drums, pump-ring castings, tappets, valve guides and machine tool ways.

Flame hardening the teeth on a sprocket improves wear resistance with minimum distortion.

For a free copy of ***"Why Moly Iron Bulletin #6,"*** *circle #2 on the coupon.*

Tempering Low-Alloy Creep-Resistant Steels

A recent British paper discusses the roles of chromium, molybdenum and vanadium in low-alloy steels with high creep strength. The relation between creep properties, microstructure changes and carbide composition is given special attention.

For a copy of ***"The Tempering of Low-alloy Creep-resistant Steels Containing Chromium, Molybdenum and Vanadium"*** *by E. Smith and J. Nutting, circle #6.*

Moly Helps High Alloys Fight Corrosive Attacks

Highly alloyed materials are playing a greater part in combating corrosion. A current paper on these alloys considers the molybdenum-bearing alloys at length and also discusses cobalt-base alloys and silicon-bearing alloys.

For copies of this paper, ***"High Alloys to Combat Corrosion"*** *by E. D. Weisert, circle #7.*

Thermenol Shows Excellent Resistance to Heat, Corrosion

Thermenol, an iron-aluminum-molybdenum magnetic alloy, compares favorably with other high-temperature materials, and in some cases promises even better service. For unlike many alloys, it doesn't lose tensile strength rapidly up to 1200 F. It also has excellent resistance to oxidizing and sulfur-bearing atmospheres at high temperatures.

For a copy of ***"Iron-aluminum Magnetic Alloy Has Excellent Heat Resistance,"*** *circle #8.*

Moly in Nickel-base Casting Alloys Improves High Temperature Service

Molybdenum is helping at least two nickel-base alloys to work more effectively in high temperature applications. One of the alloys, with 5% Mo, combines good castability with very good creep strength at temperatures up to 1800 F (much better than that of moly-free alloys). The second, with 10% Mo, shows high resistance to thermal shock.

For free copies of ***"Some Properties of Nickel-base Casting Alloys for High-temperature Service"*** *by D. R. Wood and J. F. Gregg, circle #3.*

Cast Steels Studied at Low Temperatures

The British Steel Castings Research Association has completed new studies on the effect of melting practice, composition and treatment of steel castings. Five of the seven alloy steels investigated contained molybdenum. The benefits of using molybdenum in low alloy steel castings for low temperature service are clearly shown in comparisons of 1.5% Mn and 1.5% Mn-Mo.

For reprints of ***"The Low-temperature Impact Properties of Cast Steel"*** *by W. J. Jackson and G. M. Michie, circle #4.*

New Data Available on Low Carbon Bainitic Steels

Studies have been made on new steels based on boron-0.5% Mo. Tensile strengths up to 180,000 psi can now be obtained within the bainitic range with a wide range of cooling rates. Thus these low-carbon bainitic steels offer a good combination of mechanical properties as-rolled or as-air-cooled. These properties can be obtained in large sections because hardenability is high. Good welding properties and tempering characteristics make the steels especially suitable as high-strength weldable steels, forgings, die blocks, etc.

For copies of ***"Low-carbon Bainitic Steels"*** *by K. J. Irvine and F. B. Pickering, circle #5.*

Climax Molybdenum Co., Div., Dept. 61
American Metal Climax, Inc.
500 Fifth Avenue, New York 36, N. Y.

I'd like more information on:

1 2 3 4 5 6 7 8

Name_____

Company_____

Street_____

City_____ State_____

MORE EFFICIENT DESIGN, IMPORTANT SAVINGS, SIMPLIFIED ASSEMBLY, BETTER APPEARANCE

These are some of the many benefits reported by Design Engineers who have adopted TRU-LAY PUSH-PULLS for remote control operations on literally hundreds of products

Here are typical comments recently received from equipment manufacturers whose machines or implements are equipped with these accurate and dependable remote controls:

Saves Time, Labor and Material
"The use of your flexible Push-Pulls saves us a great deal of time, labor and material. The old linkages frequently required much planning in both engineering and shop which is not required now. On some of our equipment we use Push-Pulls from 10 to 30 feet in length. They operate clutch controls on the Main Power Unit, Feed Conveyors and Delivery Conveyors."

Greater Flexibility of Design
"The principal advantage of Tru-Lay Push-Pulls in our application is that they permit flexibility in locating the control valve in relation to the operator's position."

Cost Less to Install
"Tru-Lay Push-Pulls are easier and less expensive to install than linkages for remote control of power take-off, brake and clutch. Better appearance, too."

Simple and Neat
"For several models of farm tractors, we selected your controls for their simplicity and neatness of application as governor controls."

Solution to Tough Problem
"Can be installed where straight rods are impossible . . . for Remote Control of transmissions, brakes and clutches."

Eliminates Maintenance
"Simple operation and elimination of maintenance problem are the major advantages in using your Push-Pulls."

Reduces Number of Parts
"Your Push-Pulls have eliminated links, radius rods and other lost-motion devices for remote control of hydraulic valves."

Provide ACCURATE Control
"Tru-Lay Push-Pull control cables provide minimum back-lash, even in installations up to 30 feet in length, because the cable is designed to close tolerances with minimum drag and lost motion."

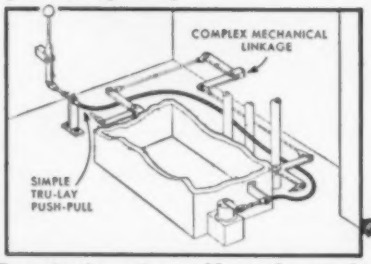
• • •

TRU-LAY PUSH-PULLS are "Solid as a rod but *Flexible* as a wire rope." This flexibility makes it possible to snake around obstructions . . . permits the ideal arrangement of all elements of remote controls.

***Advantages** of Tru-Lay Push-Pull flexibility and simplicity are pictured below—*

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Construction Equipment and **Farm Implements** provide good examples of the wide-spread use of these accurate, simple and dependable Push-Pulls. On Power Shovels, Winches, Graders, Road Oilers, Dump Trucks, Snow Plows, Engine-driven Pumps, Crushers, Tractors, Combines, Corn Pickers, Corn Row Sprayers, Corn Detasslers, Orchard Sprayers, Power-driven Tree Trimmers, Tobacco Picking Machines and others . . .

TRU-LAY PUSH-PULLS are operating unfailingly for the remote control of Hydraulic and Air Valves, Brakes, Clutches, Transmissions, Throttles, Chokes, Governors, Power Take-Offs, Spray Nozzles, Vent Directional Fins and on many other applications.

ACCO *Our DATA FILE will answer all further questions*

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

601-E Stephenson Bldg., Detroit 2
2216-E South Garfield Ave., Los Angeles 22 • 929-E Connecticut Ave., Bridgeport 2, Conn.

There is No Worry about Failures or Maintenance Costs with TRU-LAY Push-Pull Remote Controls

Long Life is a matter of record. We have never heard of a Tru-Lay Flexible Push-Pull Control wearing out in normal service. Failures, that sometimes harass users of more complex controls, are eliminated by the use of these simple, positive-action controls.

Dependable Operation of these controls is a certainty, even under the most adverse conditions . . . HOT as jet engines (note: Tru-Lay Push-Pulls are actually performing on hot jet applications) . . . COLD to 70° F below zero . . . SOAKIN' WET . . . ABRASIVE . . . or just plain TOUGH.

Freedom from Trouble is assured because of such features as . . . full protection of the inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit.

Accuracy is inherent in the basic design of Tru-Lay Push-Pulls. They are precision products, not gadgets.

Capacity ranges from light jobs up to jobs of 1,000 lbs. input. These Push-Pulls will handle jobs 150 feet or more from the control point.

"Solid as a rod, Flexible as a wire rope" aptly describes Tru-Lay Push-Pull Controls. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . it greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Adaptability to all sorts of mechanical situations explains, in large measure, the wide-spread application of Tru-Lay Push-Pulls. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters, and will work with you.

For Further Information—The DATA FILE pictured at the left contains six booklets and bulletins that will answer any further questions you may have about this versatile and dependable tool. It is quite likely that this material will point the way to a simplified solution of your remote control design problems. Write for a copy.

Houghton 1243 rubber-impregnated leather

The answer to five packing problems

• Positive seal at zero pressure • Rubber's resilience, without rubber's friction • Wear far surpassing either homogeneous or fabricated rubber • Resistance to high pressures and abrasion • Compatibility with fire-resistant hydraulic fluids and/or mineral oils

applications engineering service

Because Houghton makes both packings and fluids, they maintain a continuing packing-test program offering customer service on packings of all materials, fluids, which it also manufactures, and hydraulic and pneumatic packing applications engineering. As a result, Houghton has become "packing headquarters" for many of the leading manufacturers of hydraulic and pneumatic equipment.

An exclusive Houghton process puts pure polysulphide rubber between the leather fibers of #1243 packings. Penetration is complete.

Porosity often found in leather packings is eliminated. The packing is flexible, easy to install. There is none of the stiffness of wax-impregnation.

Wear resistance is increased by Houghton's process of molding packings with the flesh side of the leather exposed to wear, rather than the smooth, hair side. In tests, #1243 cup packings have run more than twice as long as the total service life of conventional packings, without losing the smallest fraction of their sealing efficiency.

This unique, durable material is available in pre-formed cup packings, "V" packings (which may be used in combination with Houghton rubber and fabricated rubber "V's") and "U" packings.

Write today for the latest #1243 bulletin and engineering information. E. F. Houghton & Co., 303 West Lehigh Ave., Philadelphia 33, Pa.

PACKINGS

. . . products of

E. F. HOUGHTON & CO.

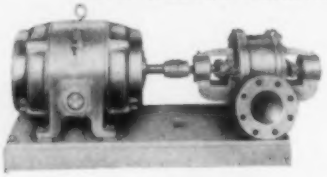
PHILADELPHIA • CHICAGO • DETROIT • SAN FRANCISCO

Ready to give you on-the-job service . . .

BUILT-IN ASSURANCE

To Help Make Your Plans Work As Specified...

F-M WESTCO PERIPHERAL PUMPS



boiler feed
condensate return
hot and cold liquids
chemicals
refrigerants, etc.

Up to 200 gpm., pressures to 900 ft. High pressure at normal operating speeds. Handle widely varying heads with little change in capacity. Sizes 1¼" through 2½".

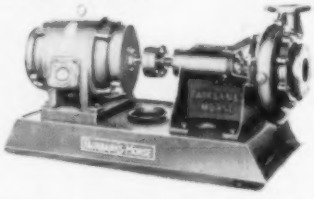
F-M BUILTOGETHER CENTRIFUGAL PUMPS

hot and cold liquids
liquid circulation
low-viscosity liquids
boiler feed
cooling towers, etc.

Up to 900 gpm., pressures to 525 ft. Close-coupled pump and motor units mount horizontal, vertical or angular. Sizes ¾" through 5".

F-M NON-CLOG PUMPS

plant waste
slurries
paper stock
fruit
fish
vegetables, etc.



Up to 30,000 gpm., pressures to 175 ft. Sizes 2" through 20". Vertical or horizontal. Bladeless or conventional.

The best-laid plans can go astray when mechanical equipment fails to deliver according to expectations or fails to give sustained peak performance. That's why Fairbanks-Morse builds something extra into all pumps so your plans work *as specified*.

F-M Pumps You Can Rely Upon

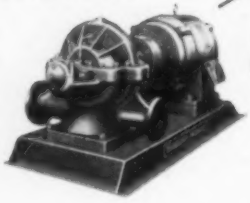
Full-rated capacity guaranteed... with built-in safety margin to assure maximum efficiency under most severe use. Rugged, durable, precision-made to maintain efficiency with minimum service.

Expert Help When You Want It

F-M Engineers are ready to work with you on any of your pump problems.

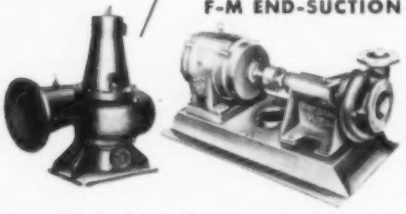
F-M SPLIT-CASE CENTRIFUGAL PUMPS

water supply; plant service
booster; circulating
air conditioning
refrigeration
chemical liquids
boiler feeds, etc.



Up to 50,000 gpm., pressures to 700 ft. Sizes 1½" through 36". Single stage or multistage.

F-M END-SUCTION PUMPS



hot and cold liquids
chemicals
circulating liquids
low-viscosity liquids
cooling towers
condenser circulation, etc.

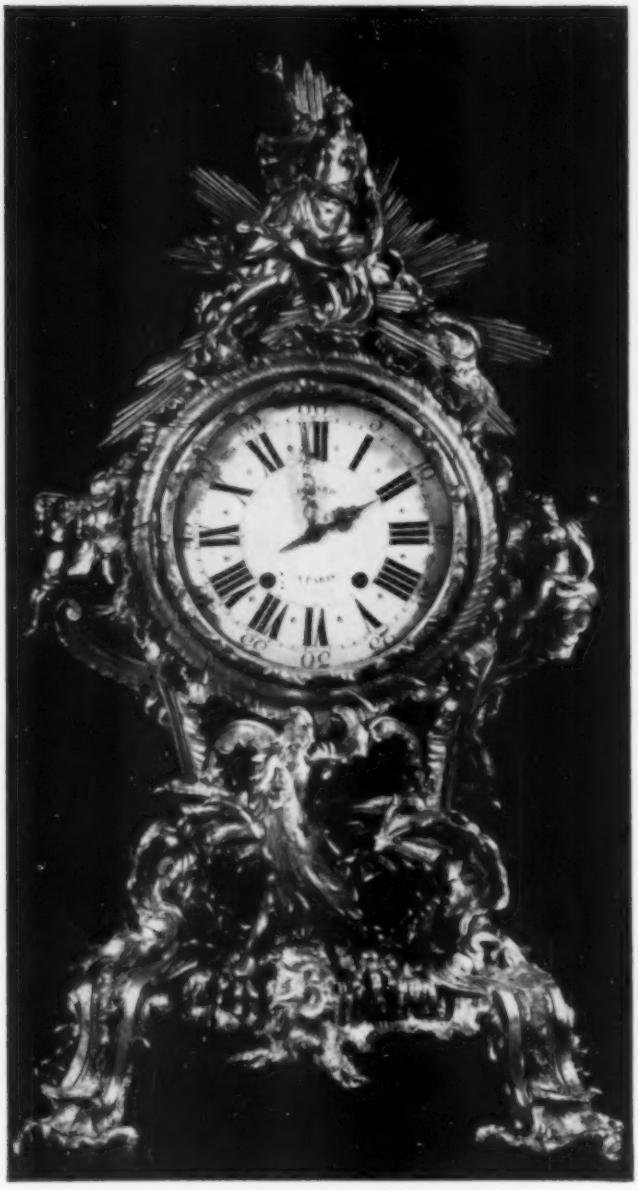
Up to 100,000 gpm., pressures to 250 ft. Sizes ¾" through 54". Horizontal or vertical.

For full information about Fairbanks-Morse pumps, call your F-M Sales Engineer or write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS



The Cleveland Museum of Art, John L. Severance Collection

Your TIMKEN® 52100 tubing will be on its way before the small hand circles twice!

WHEN you're in a rush for 52100 tubing, why not use our mill warehouse stock? We'll have your order on its way in 24 hours from our stock of 101 sizes, ranging from 1″ to 10½″ O.D. with a wide selection of wall thicknesses. It's handy to use when you need less than mill quantities, too!

And in addition to time, you can save money by substituting Timken® 52100 steel for more expensive steels. It's through hardenable in moderate sections. You can heat treat it to file hardness or temper it back to meet your needs. And you can depend on it to be uniform from tube to tube, heat to heat, order to order.

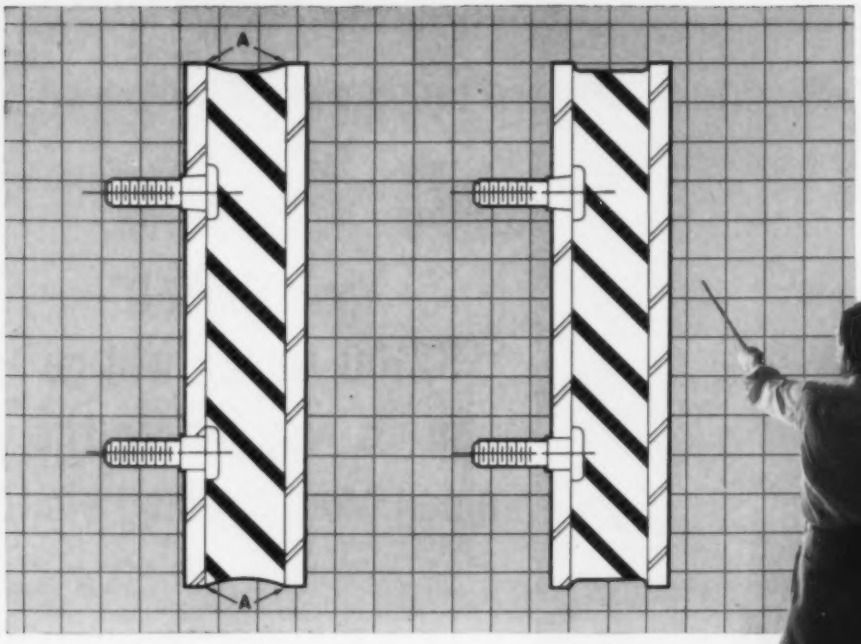
That's why Timken 52100 steel is so widely used—for aircraft engine parts, ball bearing races, pump parts and plungers, collets, bushings, spindles, grinding machine parts, precision parts and dozens of other uses.

We pioneered the manufacture of 52100 tubing in America and we're the only source of supply for all three common forms: tubing, bars and wires. So call or write your order to: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

TIMKEN *Fine Alloy* **STEEL**

TRADE-MARK REG. U.S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING



Savings in molded rubber parts begin with improved design

thru **ORCO**

CUSTOMEERING

Similar designs? Almost, but not quite. In the design at left, "A" is a stress point. The shrinkage of the rubber can cause concentrated strain at the edges of the bonded area. Ohio Rubber engineers would probably recommend the design shown at right.

Attention to important details like this is typical of ORCO's "customeering" of parts made from rubber, synthetic rubber, silicone rubber, polyurethane, and flexible vinyl, whether they be molded, extruded, or bonded to metal.

From components weighing less than a gram to parts of over 73 lbs., whatever the shape involved, ORCO's integrated research, design, electronically controlled compound mixing, and production facilities, assure component uniformity and quality to meet the most exacting requirements. Check with ORCO engineers on your next rubber or vinyl component problem. Your inquiry will receive prompt attention.

Send for free booklet "Component CUSTOMEERING rubber and vinyl parts".

THE OHIO RUBBER COMPANY

A Division of The Eagle-Picher Company
Willoughby, Ohio

DE LAVAL
IMO PUMPS

are now more versatile than ever

De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

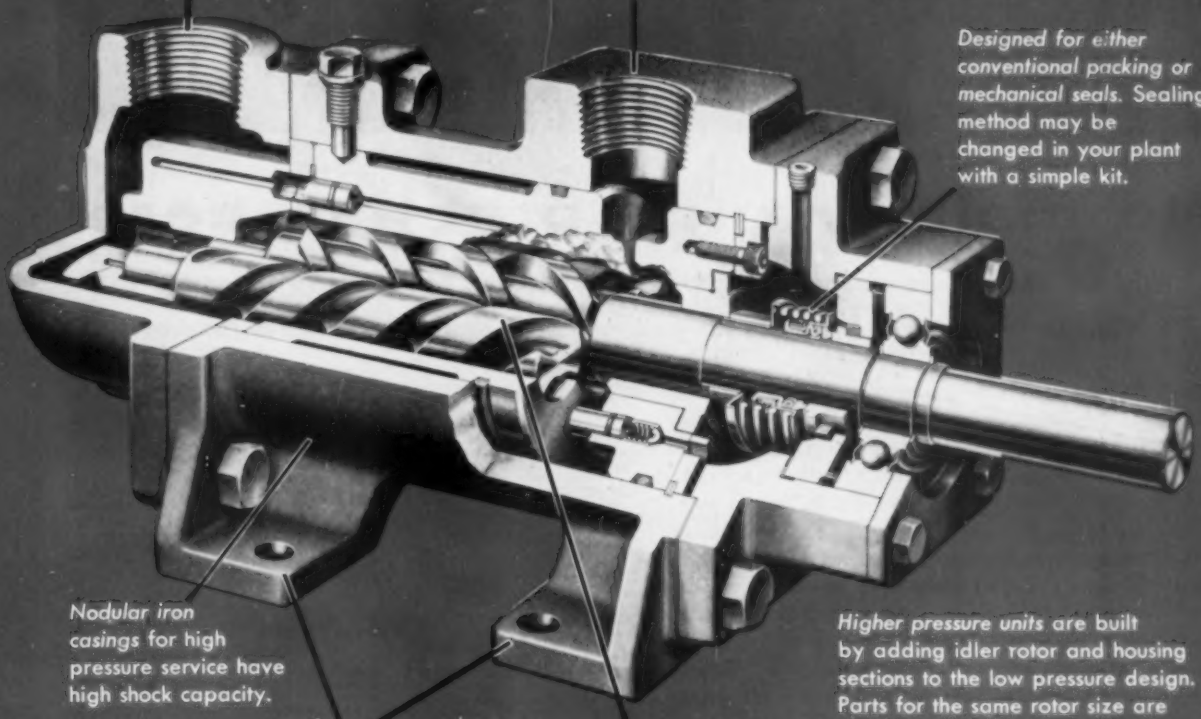
In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.

DE LAVAL IMO PUMPS can also be used as hydraulic motors.

Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.



Nodular iron casings for high pressure service have high shock capacity.

Any position mounting is possible without factory modification.

Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.

Internal parts are designed as a package so that units can be built into your machines.

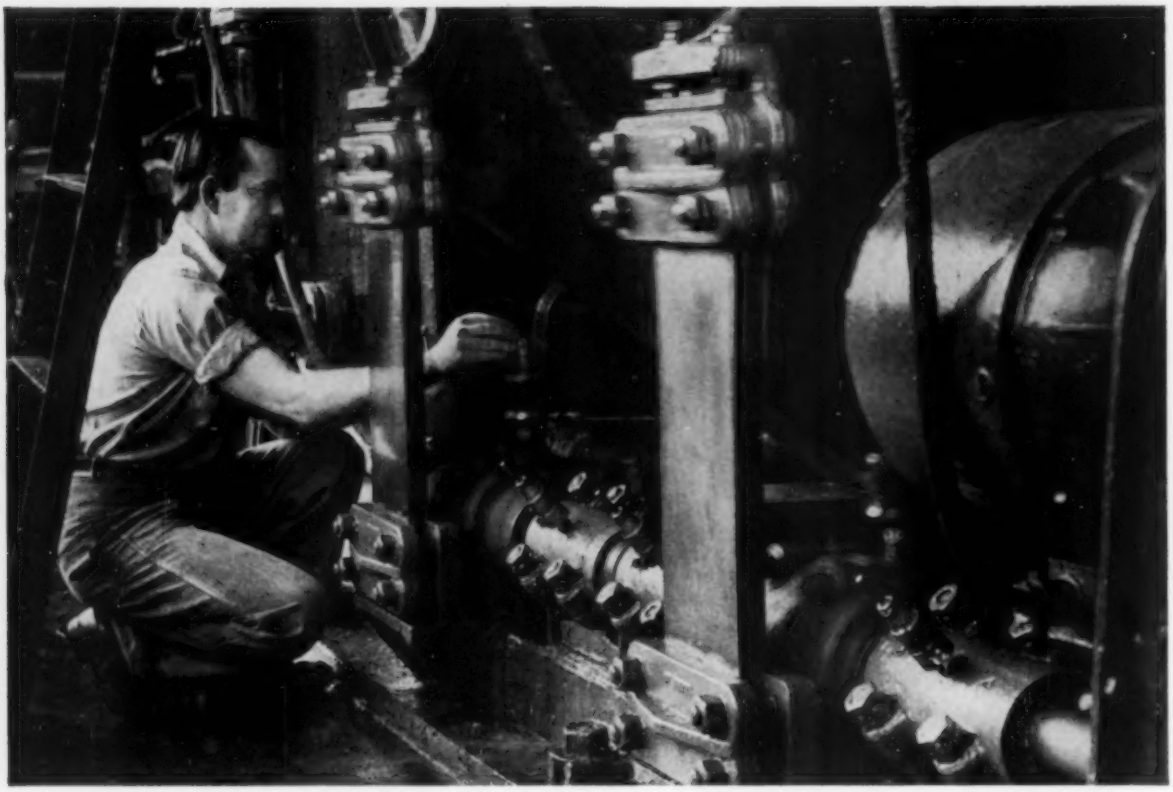
Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY

801 Nottingham Way, Trenton 2, New Jersey

DL 418



No maintenance problem here!

Four Taylor laminated plastic springs have been flexed more than one billion times under heavy loads and corrosive conditions without failure

Once the laminated steel springs supporting the oscillating tank on a rotary screen of a papermaking machine created a severe maintenance and production problem for a user of this equipment. Lubricants would not hold, rust developed, metal fatigued, and the equipment broke down. After many attempts to solve the problem by usual methods, Taylor laminated plastic springs were installed. Since then 15 years have passed, and there have been no spring failures even though the loaded tank weighs 13,000 lb. and oscillates at 300 cycles per minute, 24 hours a day, 6 days a week. The corrosive conditions around the machine have had no ill effect.

You, too, may have problems where the strength of Taylor laminated plastics, plus their moisture-resistant and wear-resistant qualities, can reduce maintenance time and replacement costs. Our application engineers will be glad to discuss them with you and also the convenience of our integrated plants at Norristown, Pa., and LaVerne, Calif.—and make recommendations. Get the benefit of their counsel by contacting TAYLOR FIBRE CO., Norristown 39, Pa.

See tables at right for properties of the Taylor laminated plastic used in the fabrication of these springs

PHYSICAL PROPERTIES

Taylor grade	Water Absorption 24 hr. immersion (% max.)		Specific Gravity	Cu. in. per lb.	Rockwell Hardness	Heat Resistance (max.)	
	1/8 in.	1/2 in.				Continuous use (°F)	Intermittent use (°F)
C	2.5	1.2	1.35	20.5	M-103	200-225	225-250

MECHANICAL PROPERTIES

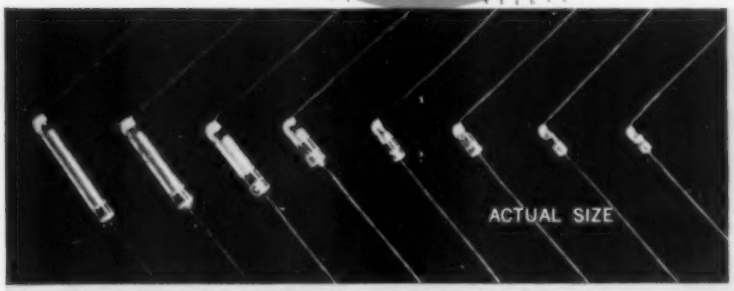
Taylor grade	Flexural Strength Flatwise (psi min.)		Tensile Strength (psi min.)		Compressive Strength (psi min.)	Izod Impact Strength Edgewise (ft./in. notch min.)	
	Lengthwise	Crosswise	Lengthwise	Crosswise	Flatwise	Lengthwise	Crosswise
C	17,000	16,000	10,000	8,500	37,000	2.10	1.90

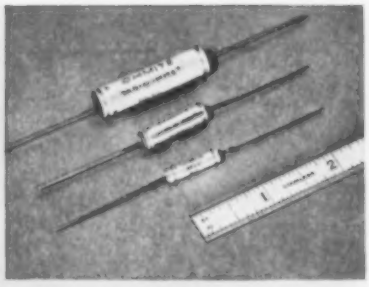
Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

NEW OHMITE® "TAN-O-MITE®" TANTALUM CAPACITORS

HIGH STABILITY
FOR —55°C to + 85°C OPERATION
HIGH CAPACITANCE
SUBMINIATURE SIZES
LONG SHELF LIFE



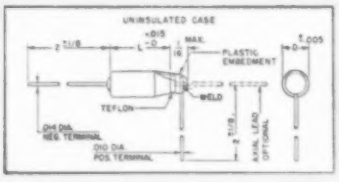


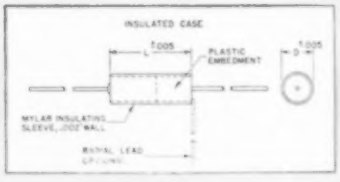
SERIES TW WIRE-TYPE TANTALUM CAPACITORS

These new subminiature, wire-type units feature greater capacitance per unit volume, lower leakage current and power factor, and small capacitance drop at extremely low temperatures as compared to other types of electrolytics. Ultrasmall for low-voltage DC transistorized electronic equipment, these new tantalum capacitors have *high stability, high capacitance, long shelf life, and excellent performance* under temperature extremes of —55°C to + 85°C. Available in eight subminiature sizes; 0.1 to 80 mfd. over-all capacitance range.

SIZE	UNINSULATED		INSULATED	
	D (inches)	L (inches)	D	L
*T	.075 (5/64)	.156 (5/32)	.082	.203
*S	.075 (5/64)	.187 (3/16)	.082	.234
*M	.095 (3/32)	.172 (11/64)	.100	.218
*A	.095 (3/32)	.250 (1/4)	.100	.312
*B	.125 (1/8)	.312 (5/16)	.134	.375
C	.125 (1/8)	.500 (1/2)	.134	.562
D	.125 (1/8)	.625 (5/8)	.134	.687
E	.125 (1/8)	.750 (3/4)	.134	.812

Smallest size is .075 (5/64) x .156 (5/32) inches; the largest is .125 (1/8) x .750 (3/4) inches. Five stock sizes (*) are available in a wide range of capacitances and voltages. Units insulated with a tough Mylar® plastic sleeve can be furnished. *Write on company letterhead for Bulletin 148B.*





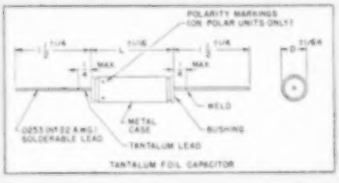
SERIES TF FOIL-TYPE

These capacitors are tantalum foil, electrolytic units designed for low voltage AC and DC applications where small size, top performance, and stability of electrical characteristics are required. Units feature unusually long shelf and operating life.

CASE SIZE	D*	L*
J	3/16"	11/16"
K	9/32"	7/8"
L	3/8"	1 7/16"

**Add 1/16" to L and 1/32" to D when insulating sleeve is used.*

Three sizes now available; .25 to 140 mfd. over-all capacitance range. Standard tolerance is ±20%. Working voltage up to 150 volts. Polar and nonpolar units are available. *Bulletin 152.* Design and construction meet military specification MIL-C-3965, paragraph 3.3.



OHMITE® QUALITY Components

RESISTORS • RELAYS • TAP SWITCHES
RHEOSTATS • TANTALUM CAPACITORS
VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
361 Howard Street, Skokie, Illinois

RMC Instruments for better Product Engineering

Tell us your requirements for indicating instruments or actuating switches and let RMC engineering skill go to work for you.

ROCHESTER
MANUFACTURING CO., INC.
214 ROCKWOOD ST.
ROCHESTER 10, N. Y.

RMC
LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

HIGH PRESSURE GAUGES

The RMC-Lindsay gauge, designed for pressures from 1,000 to 15,000 PSI, is a multiple coil, helical Bourdon tube type. The pointer is attached direct to the tube, without linkages or pivots. This gauge is made for extensive cycling, and will meet rigid vibration and over-pressure requirements—can withstand extreme conditions of shock, vibration or temperature. These gauges are made in various models to meet specified pressure requirements for a wide range of applications, including guided missile and jet aircraft service.

MODEL #6903-7 (Actual Size)

MODEL #6901
(Actual Size)

PRESSURE GAUGES

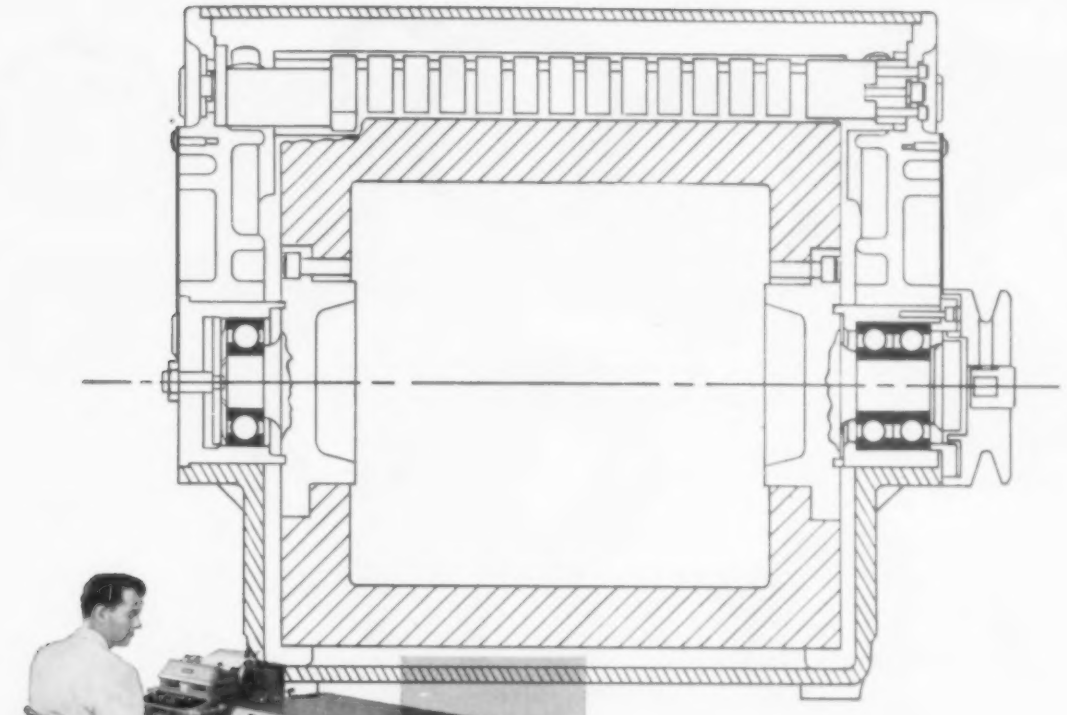
MODEL #2650—RMC pressure gauges are capable of withstanding very high overload pressures above a nominal scale reading. Various types are available in different models, sizes, etc. All are built for use on heavy-duty equipment, to maintain accurate readings regardless of mechanical vibration, or exposure to dust and weather.

PRESSURE/VACUUM SWITCHES

MODEL #2900—The RMC 2900 series is designed for service on vibrating equipment. Mechanism is sealed dust-proof and watertight. The diaphragm is Buna N impregnated and calibrated at the factory to close or open a contact at fixed pressure (or vacuum) values. Double or single terminal models. Pressures from 4 to 100 PSI. Vacuums from 4 to 26 in. Hg.

THERMOMETERS

MODEL #1848—RMC's general line of industrial thermometers cover just about every possible application. All are of stainless steel construction, with hermetically sealed dials. They are factory calibrated and pressure tested. External dial reset device permits on-the-job calibration for pin-point accuracy.



"NO ROOM FOR ERROR"

in design of desk-size LGP-30 digital computer!

Precise performance assured in Librascope's Fafnir-equipped LGP-30

Small as a desk, but it "thinks big"! No less than 4096 words can be recorded on the magnetic memory drum of the new Royal Precision Electronic Computer LGP-30. Moreover, this compact unit, made by Librascope, Inc., a subsidiary of General Precision Equipment Corporation, can be rolled where it's needed and plugged into any conventional wall outlet.

At the heart of this versatile computer, Fafnir super-precision type ball bearings maintain the precise alignment and high sensitivity required of the drum component. Counterbored to take a wide range of thrust, and radial loadings, these bearings provide the rigidity, extremely close-running accuracy, and low torque essential in this exacting application.

Fafnir's contribution to the development of the LGP-30 is another case history example of the high caliber and comprehensive scope of Fafnir design engineering services available to *you*. Take advantage of it when you have a bearing problem. The Fafnir Bearing Company, New Britain, Conn.

The new Royal Precision LGP-30 is a serial, single address, fixed point binary, stored program digital computer featuring simplified design and ease of operation. The unit is designed to make computer use economical and simple enough for more widespread application.

Fafnir Super-Precision Type Ball Bearings are used in duplex pairs, mounted back-to-back, at the pulley end of the LGP-30 memory drum, and singly at the opposite end. These preloaded, angular-contact bearings, equipped with composition or bronze retainers, are widely used in precision-built mechanisms.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

PRECISION WASHERS

For automatic transmissions and similar bearing applications

FEDERAL Mogul

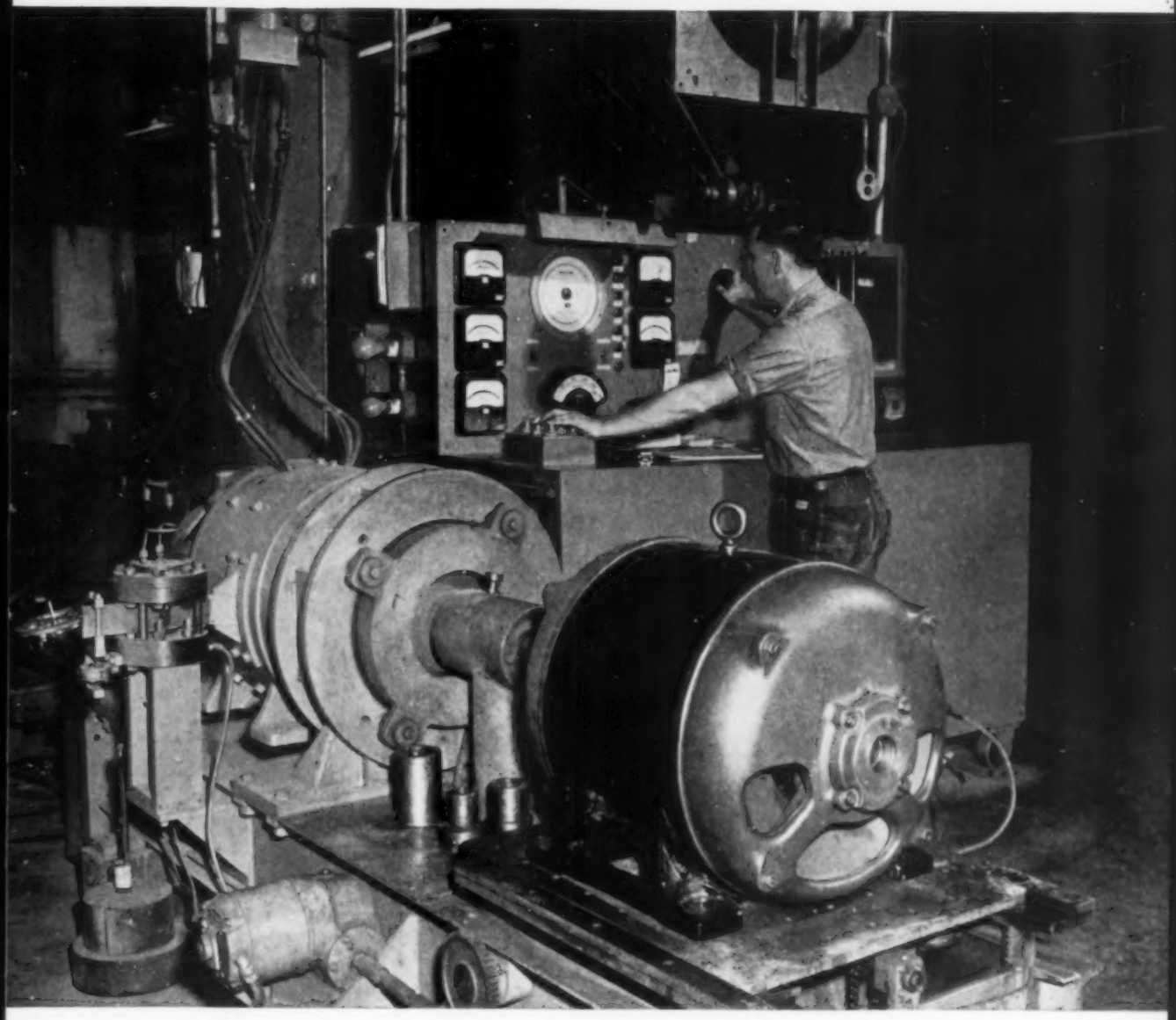
Solid steel or bronze; steel faced with babbitt or copper-lead, or copper-lead on *both faces*. Flat, spherical or special shapes. Grooves, holes, nibs, scallops or lugs. O.D. 1″ to 6″. Wall thickness: solid, .028″ to .141″; bimetal, .034″ to .141″. Cold rolled for heavy-duty. Large capacity. Complete engineering service.

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

. . . Your best motor investment is Century



Century tests every motor . . . to make sure it gives full performance

Rigorous performance tests are conducted to prove these electric motors before they get the Century stamp of approval. When you see a Century motor put through its paces you know this approval is well earned.

In this plant there is no "random sampling" or "statistical average" on performance. Century tests every motor . . . big as 400 HP, small as 1/20 HP . . . to make sure you get the performance you expect. Field records—and our customers have furnished us impressive ones—are further proof your best motor investment is Century.

Specify Century's individually tested motors to take care of your requirements. Call your local Century man or Authorized Century Distributor.

Century MOTORS

CENTURY ELECTRIC COMPANY

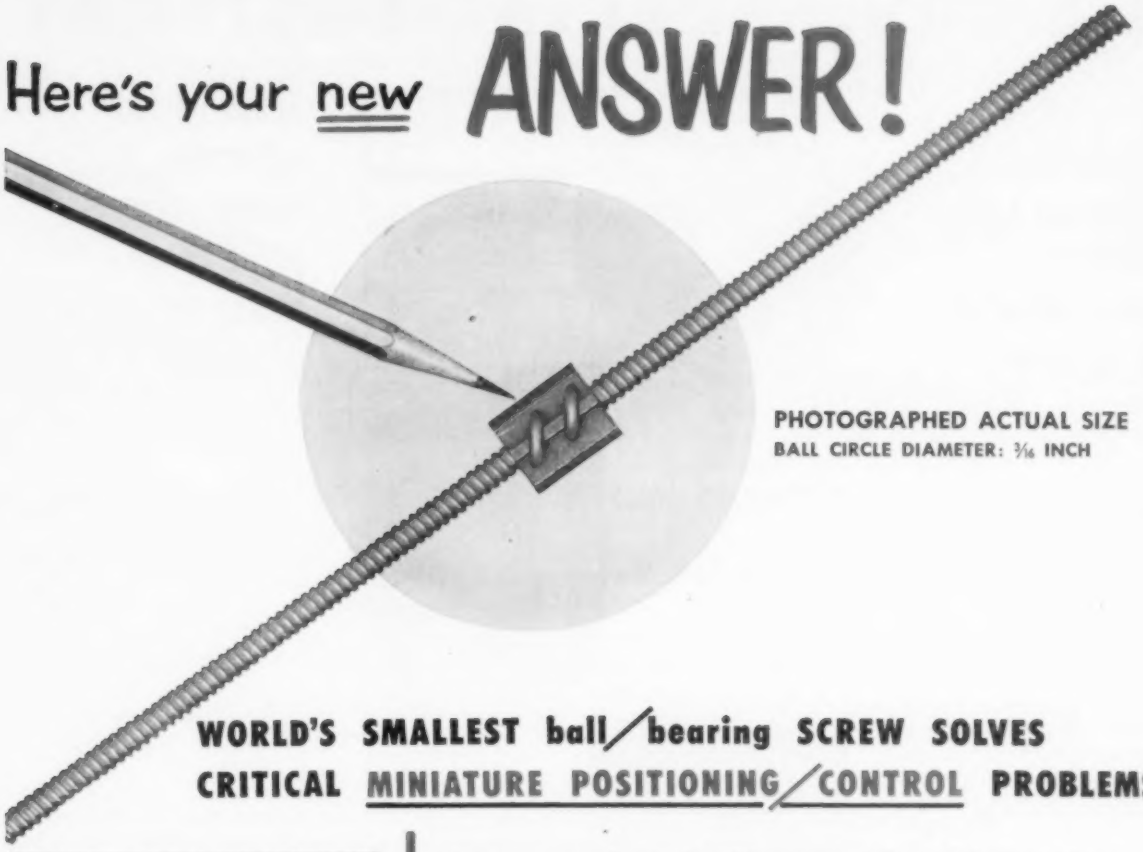
St. Louis 3, Missouri • *Offices and Stock Points in Principal Cities*

get the picture?

BETHLEHEM STEEL

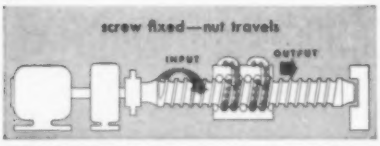
BETHLEHEM STEEL

Here's your new ANSWER!

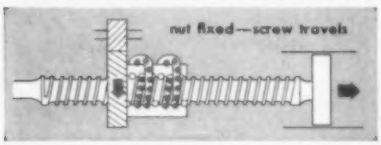


PHOTOGRAPHED ACTUAL SIZE
BALL CIRCLE DIAMETER: 3/16 INCH

WORLD'S SMALLEST ball/bearing SCREW SOLVES CRITICAL MINIATURE POSITIONING/CONTROL PROBLEMS



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque than acme screws.



SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with unprecedented efficiency.

An unprecedented achievement in minimum size and weight—maximum efficiency, dependability and service life for ultra-precise controls.

It's another first from Saginaw—and the possibilities it opens up for improved electrical and electronic controls are limited only by your imagination! Radar tuners, missile and rocket guidance and telemetering systems, automatic switchgear, electronic machinery controls are just a few of the applications where this new miniature Saginaw b/b Screw will solve critical positioning/control problems. *It's so compact and light,* you can save substantially on space and weight. *It's so efficient,* (over 90%) you can use much smaller motors and gear boxes. *It's so precise,* you can position components within .0005 inch per inch of travel. *It's so dependable,* you can rely on remarkably long service life even in adverse environments.

You will find our 1958 Engineering Data Book extremely helpful in planning applications, or experienced Saginaw engineers will gladly make specific recommendations without obligation. Just phone, write or mail the handy coupon.

Saginaw

ball bearing Screw

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS • SAGINAW, MICHIGAN
WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

SEND TODAY FOR FREE 36-PAGE ENGINEERING DATA BOOK . . .
or see our section in Sweet's Product Design File

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 8PE, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____

USE READER SERVICE CARD FOR MORE INFORMATION

TIMERS...SPECIAL DELIVERY

Standard or special— Industrial Timer makes rapid deliveries on all models

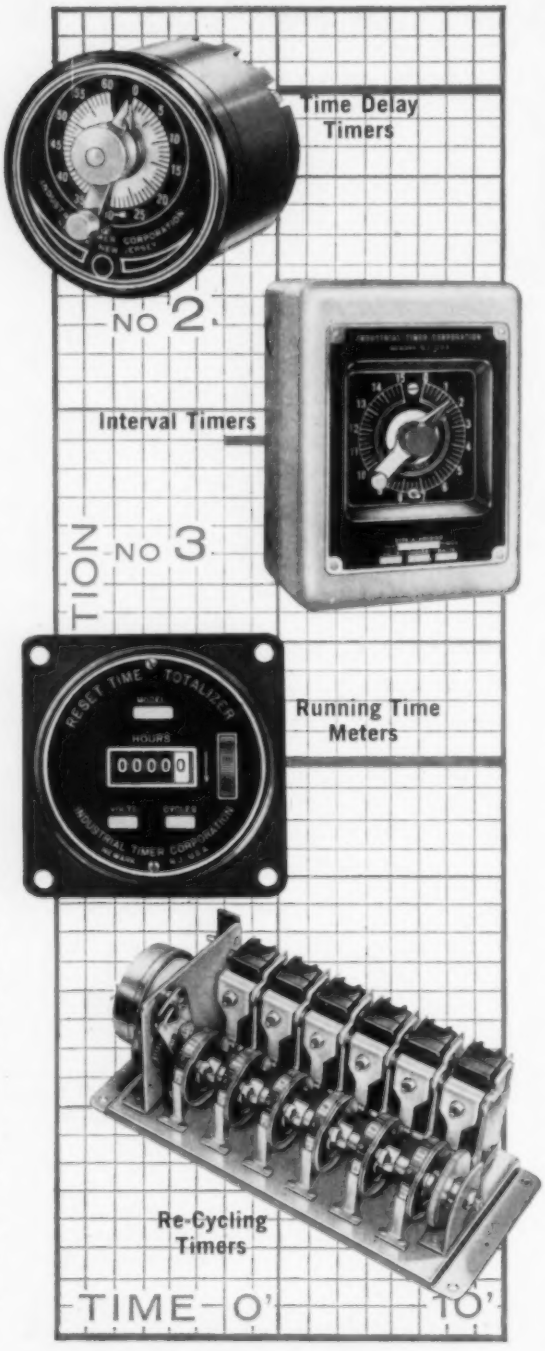
Sometimes you need a standard model timer . . . other times you need a special. Either way we can give you the extra rapid service you may need because of the efficient way we design, manufacture and stock timers for industrial applications.

To meet *all* of the widely varying needs of our customers we manufacture a complete line of timers in the four broad classifications illustrated here:

1. TIME DELAY TIMERS
2. INTERVAL TIMERS
3. RE-CYCLING TIMERS
4. RUNNING TIME METERS

From these we have already developed 20 basic types which can be combined in endless number of ways . . . to date, our engineers have combined them into over 1000 different models. So what might seem to be a special timer requirement to you, will very often be a standard timer in our large stock, and that is the reason we have the ability to fill special orders so quickly. And as far as standard timers are concerned we can give overnight service if necessary.

So, for the utmost in all-round service depend on us for this outstanding combination: deliveries "Immediate on Standards . . . First on Specials".



Speed up your automatic control projects— profit by our timing application experience

No need to let timing problems delay you in your automatic control projects when you can place them with us and get faster solutions. Even though no two automatic control jobs are ever exactly alike, and even though the timer requirements of each are very different we have established an excellent record in helping out in these situations.

20 years of experience in analyzing complex timer applications has provided us with the special knowledge required to give our customers the right answer in near-record time.

Our large stock of standard and combination timers enables us very often to fill orders for these requirements without any time loss because we have already developed so many new combinations specifically for automatic control functions.

Extra special automatic control timer — this calls for original designing. Our engineers will go right to work and get the job done. That's the way we grow and we like it.

Whatever your control problem, you have everything to gain by submitting it to our timer specialists. They'll come up with the answer — almost with the speed of automatic control itself.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

1415 McCARTER HIGHWAY, NEWARK 4, N. J.

AFFILIATE—LINE ELECTRIC COMPANY

SAVED... 34 CARLOADS OF COAL PER YEAR

...BY THE USE OF NEW COLD BONDERITE SYSTEM

That's the way one plant figures it. 1700 tons of coal saved per year because the Cold Bonderite System cuts steam requirements for the phosphating line by as much as 70%.

Have you asked the Parker man about the new Cold Bonderite System for your phosphating line? There's no reason for you to go on paying high steam costs when this new low temperature combination produces high quality results with real economy.

Your request for information on the new Cold Bonderite System will get high priority from us. Write, call or wire today.

Since 1914— leader in the field

PARKER RUST PROOF COMPANY
2179 E. Milwaukee, Detroit 11, Michigan
Tel: TRinity 5-3377

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

*Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.

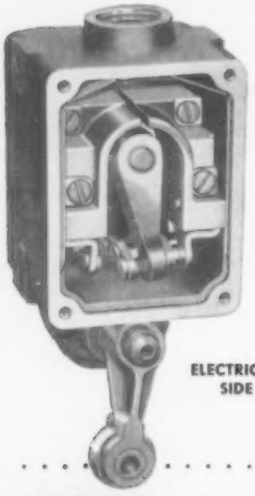
PROVED...by millions of contacts

NATIONAL ACME
SNAP-LOCK
TRADE MARK

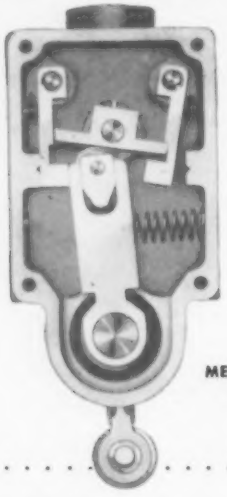
As illustrated below, National Acme SNAP-LOCK Limit Switches employ a basically simple yet positive *snap-action* locking mechanism—with extremely few moving parts. Thus wear is reduced to a minimum and dependable trouble-free service, far beyond normal limits, is assured.

The double-throw contact lever, connected directly by shaft with the latch bar, carries self-wiping coin silver contact points to assure quick action make or break—reducing wear ever further.

Electrical and mechanical sides are separated by a wall within a sturdy die-cast housing which is fully insulated and is dust and oil resistant. Can also be furnished water- and oil-tight.



ELECTRICAL SIDE



MECHANICAL SIDE

THE ORIGINAL
SNAP-ACTION LOCKING SWITCH

SNAP-LOCK LIMIT SWITCHES. Made in single-pole and double-pole series, in four types: Standard, Short Travel, Neutral Position and Push Lever. With the exception of the Push Lever Switch, all are adaptable to special enclosures for hazardous location service and may be used with various styles of operating levers. For AC or DC service.

and now . . .
a new design concept for **CONTROL STATION SWITCHES**
the heavy-duty . . . oil, water, dust tight **GOLD-N-RING**
made by machine tool builders to machine tool specifications

Heavy duty silver-alloy contact points provide maximum electrical capacity, long life.
Heavy duty terminal screws have ⅜" thread contact to prevent stripping during installation and permanently secure wires for continuous, trouble-free service.
Single or double-pole contact block assemblies—can be used interchangeably with several types of GOLD-N-RING push button and selector operator heads.
Rated for 600 volts—AC or DC. Meets all Joint Industry Committee and National Machine Tool Builder's Association requirements.
Protected against oil and water seepage in operator head by Sealtight oil-resistant rubber diaphragm.
Easily replaces existing switches.

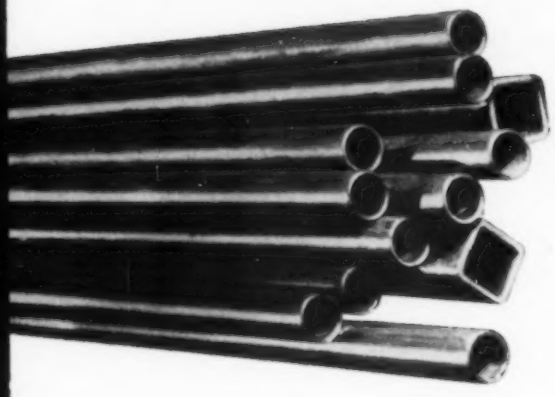
ELECTRICAL MANUFACTURING DIVISION

the National Acme company

170 EAST 131st STREET, CLEVELAND 8, OHIO

"Whom do I call for mechanical tubing?"

"Why, your USS Shelby Distributor, of course!"



When a steel tubing problem confronts you, get in touch with your Shelby* Distributor. His ideas, experience and engineering know-how will prove most valuable.

Your Shelby Distributor carries a complete stock of USS* Shelby Seamless Mechanical Tubing—round, square, rectangular, or other special shapes in commercial sizes from ¼" OD to 10¾" OD. Wall thicknesses from .035" to 2.000" in a wide range of steel grades and anneals.

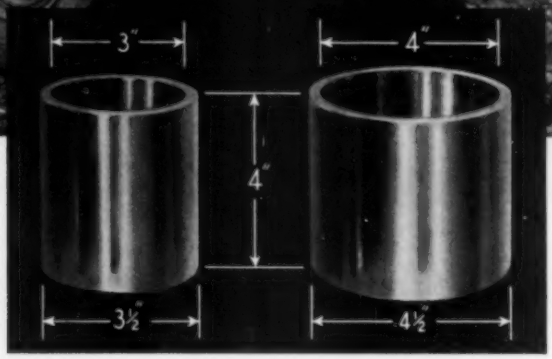
So contact your USS Shelby Distributor. He is experienced, capable and close at hand. He gives speedy, efficient service. Contact him!

"Shelby Tubing is made by the world's largest and most experienced manufacturer of tubular products—National Tube."

National Tube
Division of United States Steel

*TRADEMARK

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division
United States Steel Export Company, New York



OILITE

SELF-LUBRICATING

BEARINGS

prove a match for top payloads on ATHEY Rear Dump Trailers

Oilite* Bronze Bearings have proven more than a match for the 22 and 34-ton payloads on Athey Rear Dump Trailers.

Oil-cushioned against shocks and impacts, these Oilite heavy-duty bearings have demonstrated that they will withstand years of punishment and still give satisfactory service. They require only infrequent lubrication and help Athey substantially increase the dependability of its hauling units. Yet, Oilite Bearings *cost less* than many other type bearings!

No wonder more and more designers are specifying popular Oilite self-lubricating Bearings for motor vehicles, appliances, engines, power tools, machinery and countless other products.

Contact your local Oilite Engineer today. He'll gladly provide complete design information to help you make your bearing and bushing applications low-cost, dependable and maintenance-free. Look for him in your telephone directory under "Bearings—OILITE" or write direct to Dept. A-4.

TYPICAL PROPERTIES OF SELF-LUBRICATING BRONZE OILITE BEARINGS †

Porosity, %	18-23
Ultimate Tensile Strength, (psi)	18,000
Compressive Strength (psi)	20,000
Elongation, % min. in 1"	10
Brinell Hardness	40

† Other materials and physical properties available.

* REGISTERED TRADEMARK
ONLY CHRYSLER MAKES OILITE

the most trusted name in powder metallurgy

SINCE 1929 — OILITE

AMPLEX DIVISION

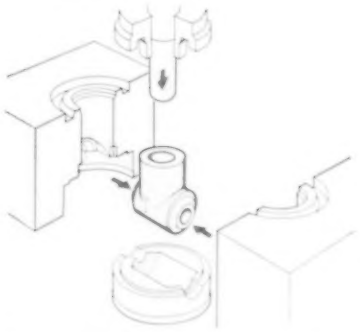
CHRYSLER CORPORATION, DETROIT 31, MICHIGAN

SELF-LUBRICATING BEARINGS • PRECISION PARTS • METAL FILTERS • FRICTION UNITS

CAMERON SPLIT-DIE FORGINGS FOR NUCLEAR POWER PLANTS

The Cameron split-die process has made ferrous forging history in components for extreme service. These AISI Type 304 stainless steel check valve bodies for nuclear power plants are another chapter in the same story. The Cameron processes were perfectly suited to produce these unusual forgings. Even though test requirements exceeded all normal procedure, we were ready to meet the exacting specifications and complete another forging contract. Most important, performance in end use could be predicted and fear of failure eliminated.

Ferrous forgings to 8,000 lbs. produced by this method emerge from our presses in near final form. A vast array of shapes and sizes, heretofore impossible to forge in one piece, are now solving knotty problems in many demanding applications.



Every single production phase from melting the high quality steels for our ingot supply through blooming, forging and heat treating to final machining is performed in our shops under constant control. Men, instruments and machines are teamed to make results predictable. Grain structures in these remarkable forgings are excellent, welds are eliminated, and machining is made easier. The result is a better component which often costs less.

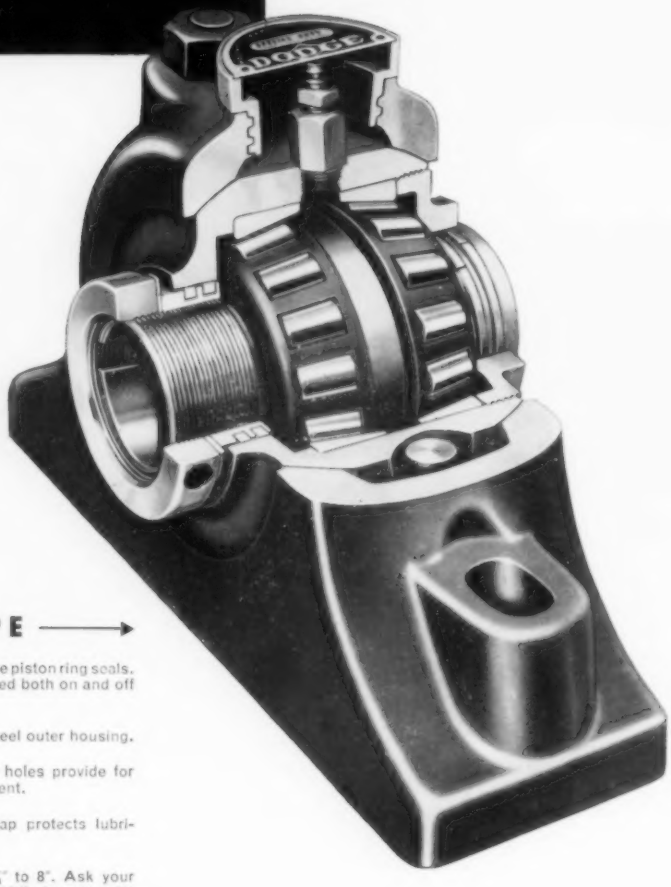
Extending the design scope of ferrous forgings has made Cameron important in solving many problems which confront advanced design today. Extreme service components for airframes, jet engines, guided missiles and a wide variety of other end uses are finding a solution in the Cameron split-die forging process. If you have a problem . . . call, write or come by

Cameron
IRON WORKS, Inc.
SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas

DODGE PILLOW BLOCKS

Timken Bearing Equipped

America's super-quality line—with a 34-year record of keeping performance *up* and costs *down!* Five types—to fit practically any service condition. All assembled, adjusted, lubricated and *sealed* at the factory for precision performance—long life—dependability.



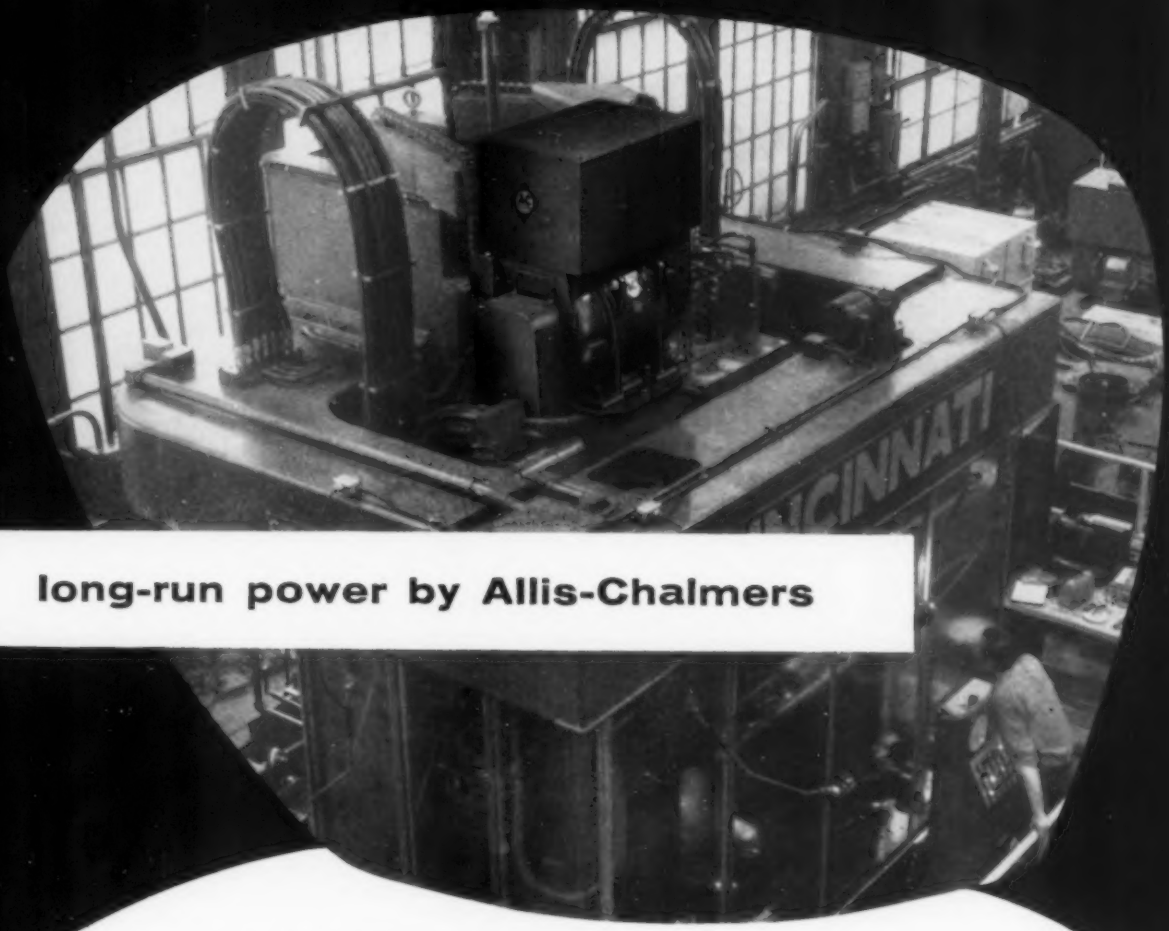
SPECIAL DUTY TYPE →

- Designed for extreme precision and high load capacities.
- Fully self-aligning.
- Special Duplex Timken Roller Bearing with tapered bore.
- Split tapered sleeve with straight cylindrical bore extends through entire length of housing.
- Easy to mount or demount. Adapter nut (or collar) clamps adapter sleeve to shaft with extreme firmness.
- Automotive type piston ring seals. Bearing is sealed both on and off the shaft.
- Rugged semisteel outer housing.
- Elongated bolt holes provide for lateral adjustment.
- Special dust cap protects lubrication fitting.
- Shaft sizes 1¾" to 8". Ask your local Dodge Distributor—or write us for Bulletin A670 giving complete technical data on America's most complete line of mounted bearings.

DODGE MANUFACTURING CORPORATION, 1200 Union St., Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE
of Mishawaka, Ind.



long-run power by Allis-Chalmers

Even the worst atmospheres can't hurt NEW self-cooled dc motors

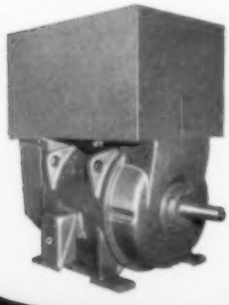
Oil concentrations, dirt, moisture, fly ash, all types of dust — none can affect the long-run power of these new totally-enclosed, self-cooled dc motors from Allis-Chalmers.

For machine tools, steel mill drives, paper mills, cement and rubber plants, these motors are ideal. Here's why:

- Volume of cooling air is *not* affected by motor speed. Outside air is drawn into heat exchanger unit by blower and circulated over the frame. Hot motor air is removed by the exchanger.
- Filters sift impurities from outside air as it enters the heat exchanger.
- Self-contained heat exchanger unit may be quickly removed for maintenance. Further, dc brushes and commutator are also readily accessible.
- Motor-heat exchanger combination is so constructed as to allow top, sidewall or ceiling mounting.

COMPLETE LINE of new dc motors is available from 10 hp to 400 rpm through 200 hp. They are backed by same nationwide engineering service that stands behind all types of Allis-Chalmers motors from 1 hp up.

See your A-C representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.



ALLIS-CHALMERS

A-5731

creative designing calls for an open mind

Leonardo Da Vinci's design for an odometer *Model courtesy of IBM*

EVEN DA VINCI'S ODOMETER COULD HAVE BEEN BETTER WITH HELP FROM AN SKF ENGINEER.

An SKF engineer can afford to concentrate on your bearing problem rather than his own product line—because the SKF line includes all four types of ball and roller bearings in many thousands of sizes. This gives him the kind of flexibility he needs to keep an open mind on any bearing problem. Give your problem to SKF and see. 7336

Spherical, Cylindrical, Ball, and "Tyson" Tapered Roller Bearings

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

*REG. U. S. PAT. OFF.

Announcing NEW SOURCE for stainless steel wire

J & L Stainless Steel Division's New Wire Mill Offers Wide Range of Wire Sizes

The increasing use of stainless steel wire in new product development, old product improvement and for experimental purposes has placed a new responsibility on the manufacturer of quality stainless steel.

To meet this growing need, J & L Stainless Steel Division is pleased to announce the opening of its new wire mill . . . to make available stainless wire in a wide range of sizes, finishes and coatings.

For data regarding wire, its properties and uses, consult our Stainless Steel Wire Manual. For special applications write in detail giving complete information about your requirements.

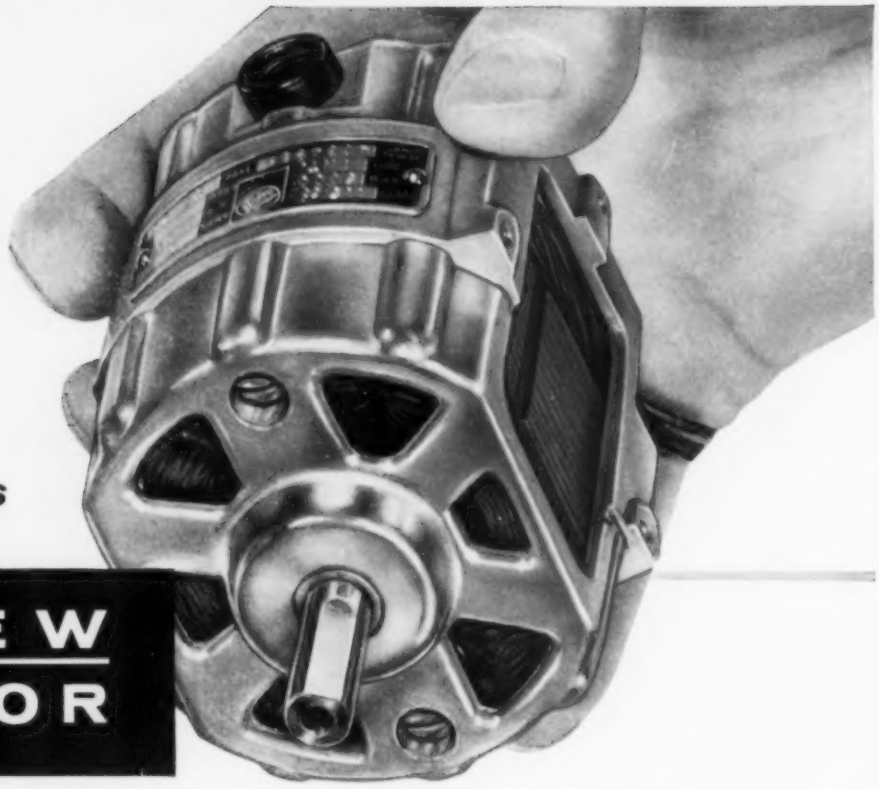
Wire now for your copy of J & L's new Stainless Steel Wire Manual.

Improve your Products with . . .

J&L STEEL STAINLESS

BAR • WIRE • SHEET • STRIP

Jones & Laughlin Steel Corporation • STAINLESS STEEL DIVISION • Box 4606, Detroit 34



BODINE
Announces

A NEW MOTOR

Type FSE-23 for intermittent duty applications such as adding machines, calculators, check protectors, check signers and actuators

It's small, only 2 5/16" high . . . it's light, only 1 pound, 11 ounces . . . it's rectangular in shape, fits into minimum space . . . and it packs plenty of power!

The FSE-23 is definitely a Bodine-quality motor . . . yet it's economically priced because it has been designed and engineered for economical, high volume production.

Here's a 33-second thumbnail story of the new Bodine FSE-23 motor:

series wound	improved armature and field lamination design for high starting and accelerating torques
self-ventilated	
1/40 horsepower	
5000 rpm nominal speed	dynamically balanced armatures for reduced motor vibration and noise
single direction rotation (clock or counter-clock)	
115 volts, 60/DC	motor shaft extension, 5/16" diameter by 15/16" long . . . with .020 flat
two part aluminum die-cast housing	

the power behind the leading products

BODINE
fractional / horsepower
MOTORS

JUST PUBLISHED! For the complete story of the new Bodine FSE-23 motor, ask for your copy of bulletin No. 1034.

BODINE ELECTRIC CO., 2260 W. Ohio St., Chicago 12

PERSPECTIVES

in design and development . . .

Our Long Weapons-Development Lead Time

If a company is lucky, it can make a reasonable profit on an R & D contract that it gets from the Government. But for the average company this work results only in a profit of 1 to 1½%. This is why most companies in a position to do so, take on only the R & D work that appears to have a good chance of being successful, for the money lies in the production contract that usually follows. One result: development lead time makes much military equipment obsolete by the time it gets in use.

To support military programs, industry must of necessity tie its R & D programs to possible production contracts. Government laboratories have said they are the ones to do the R & D on weapons because they can continue development work in this field when periods of international stability (when were they?) make it unprofitable for industry to do so. But the fact remains that about three-quarters of military R & D is done by industry, while government labs get the remaining one-quarter.

It's Twice Russia's Lead Time

Ellis A. Johnson, Director of the Operations Research Office of Johns Hopkins University, says we must accept the fact that Russia can fully develop a new weapons system in five years, but that the same task takes this country 10 years. He continues, "Most of the creative weapons development and design is done by the defense industry. In theory the guidance and management of this effort comes from the military officers of the Department of Defense. It is important to note that civilians with military research and development experience have, except for a small and relatively unimportant residue, been organized out of all of the positions of management responsibility and authority for military R & D programs in the Department of Defense. This was a deliberate action taken by the three Services, acting in concert, beginning shortly after the end of World War II. It culminated in the dissolution of the Research and Development Board, and the Office of Scientific Research and Development.

"The direct influence of science and engineering within the Department of Defense and at higher echelons of the Government now depends on the shadowy facade of scientific advisory committees who actually have no responsibility or authority for development programs, who have negligible influence on these programs, and who are relatively unacquainted with the substantive content of the military-technical problems involved. Almost the entire burden of weapons development, then, falls on industry.

"There is no formal and systematic method to keep industry informed of the tactical and strategic military requirements. The industrial contractor can formally have access to tactical and strategic military requirements on a need-to-know basis—only after he has a contract.

"This has led, and still leads, to more and more study contracts and to extensive informal discussions. These usually result in proposals by industry, either formally or informally, for new military weapons and weapons systems. After these are processed within the Department of Defense, in a time-consuming cycle in which the compatibility of the proposal with fiscal, tactical and strategic constraints is considered, the requirement is fed back to industry for competitive bids. Often the industry originating the requirements is the successful bidder.

"It is obvious that this random and grotesque procedure not only extends

(Continued on page 69)

Readin', 'Ritin', and Reliability

Synthane plastic laminated bushings and breaker arms for automotive ignition.

Dependable operation of a school bus, a truck, or your own car involves the functioning of many parts. One breakdown can wipe out the memory of ten thousand trouble-free miles.

Some of these parts are made of laminated plastics. They're usually unseen, unsung, small in size yet efficiently performing their job.

Their cost is relatively insignificant when compared with the cost of equipment in which they work, but it should be sufficient to insure dependability.

Actually, what you pay for Synthane laminated plastics is little or no more than you'd pay for any other plastic laminate. But the Synthane price includes top quality materials, product control, excellent facilities and workmanship, an assurance of continuous supply, and a long reputation for fair dealing.

If you are interested in a reliable source of laminated plastics—sheets, rods, tubes, or completely fabricated parts, write for an interesting catalog or call our representative nearest you.

SYNTHANE

SYNTHANE CORPORATION, 4 RIVER RD., OAKS, PA.

the time from concept to initiation of development, but it operates under the most severe handicap possible with respect to any high assurance that the development is best suited to meet US strategic requirements."

Stretch-out and Look for Work

Beside making a profit, any company doing R & D work for the Government must be able to keep the scientists and engineers in its industrial development labs busy. Since it takes several years for a new employe in a company to become fully productive, it is impractical, indeed impossible, for a company to hire and fire research and development people on a short-term basis and still retain the competence necessary for successful development. To do this requires a steady work-load, which is contingent upon a backlog of development projects.

Consequently, the development time for each project is stretched out, increasing the lead time as the next project waits its turn on the priority list. But if the company has no backlog of development contracts, the current—and perhaps last—program gets the slow-down treatment while company sales engineers work to get some new contracts.

Pick only the Good Possibilities

Commenting on the companies that choose and process only those developments that appear to have a good chance of being successful, Mr. Johnson adds, "This leads to development that is highly weighted in the direction of product improvement, since high-profit, high-risk development programs are too uncertain to provide assurance that the production facilities of the company will be employed. Thus, our present industrial-military partnership tends to result in slow, steady, but mediocre progress."

Still another bad situation is the Government's use of cost-plus-fixed fee contracts. They have two effects: (1) In development programs they tend to result in an exorbitant use of technical personnel for each development; as the fee is always tied to the total cost, the greater the cost (the greater the number of scientists and engineers working on a weapons development), the higher will be the profit to industry—there is thus no incentive towards the economical use of scientific and engineering personnel; (2) although it might result in a high profit, incentive to take a risk is reduced, because there is no immediate reward for success, or punishment for failure.

Mr. Johnson also feels that because the Defense Department stresses an immediate payoff in useful end-item weapon systems, it has led to a serious neglect of applied research and of component and subsystem development.

Product Procurement a Different Story

While many feel that military R & D is not a lucrative field, they do like the production side of the picture. In an after-hours bull session following a recent technical conference, comments like this were heard, "The military is being taken for a ride with price tags on some of the equipment. They pay about 10 times the price industry would pay for almost the identical component." One person said, "I know of a magnetic friction clutch that cost the military $100 and a small servomotor that cost $160. Industry wouldn't have paid one-tenth that amount."

Only recently the Comptroller General accused Chrysler Corp. and the Army of failing to control the high costs under the $124-million contract for the production of the Redstone missile. The Comptroller charged that Chrysler paid subcontractors as much as 60% more than was necessary for some 20 parts. It claimed that a subcontractor charged an average of $36.42 for 395 pieces ordered in 1955, and that later on Chrysler got the same parts, after competitive bidding, for $2.52 a piece. The General Accounting Office also jumped on the Air Force for its negotiated contract with McDonnell Aircraft for fighters. —Paul Anderson

ND FACTS

PHOTO COURTESY OF THE OLIVER CORPORATION, CHICAGO, ILLINOIS

THESE LIGHT-DUTY DISC BALL BEARINGS NEED NO SERVICE!

That's right! There's no "downtime" for relubrication or other periodic attention!

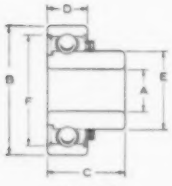
These New Departure Disc Bearings are efficiently sealed to shut out dust, dirt, moisture and *wear*. Deep-grooved races give *extra stability* where misaligning loads occur. Their machined bores fit standard-size machine bolts to give you economical, simplified mounting.

Count on New Departure, as do other leading farm implement manufacturers, to help you add *sales appeal* and *design simplicity* to your products.

Left, a Type I bearing in single-mounted grain drill disc. Recommended where extremely contaminated conditions require extra sealing precautions.

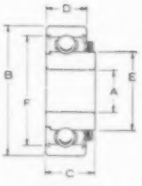
Left, a Type II Light-Duty Disc Bearing mounted in double-disc furrow opener, uses standard ⅝" machine bolt.

PRINCIPAL DIMENSIONS



TYPE I

Type	Bearing	Bore A	O.D. B +.0000 −.0005	Inner Ring Width C ±.005	Outer Ring Width D ±.005	Inner Ring Outside Dia. E	Outer Ring Inside Dia. F
I	87504A16	.632 .626	1.8504	1.125	.5512	1.1585 1.1575	1.634
II	87504U	.632 .626	1.8504	.686	.5512	1.1585 1.1575	1.634



TYPE II

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

Product Engineering HORIZONS

May 12, 1958

The Great God NEW

Ancient civilizations all had their idols; ours has one too. It is the Great God New. We worship models and drawings, descriptions of what is to be. We hover over our radios and TVs, devour newspapers and magazines, talk to people, attend meetings–all to get news.

But news is a strange sort of thing. It is a spirit, a sprite. It is not a happening, but a report of a happening; not the event, but the description of the event. We are elated or devastated, not by an actual occurrence, but by good or bad news of it.

This of itself is a harmless thing, unless it is carried too far. We have the spectacle of the man, the company or the country speaking loudly of what it intends to do, or thinks of doing, making the report sound like accomplished fact. We have the publicity seekers converting such things as governmental investigations, legal battles, charges against man or company, or even threats of litigation into a Roman holiday–the recently perfected technique of "trial by newspaper." And we even have the deplorable cases in which the news is manufactured–a recent example being the premature buildup on satellite launchings.

Beyond all that, the gravest danger lies in mistaking news of the event for the event itself. We hear of the new idea or new method when it is proposed; our minds, excited by the constant stream of sensational announcements, seek avidly for more of the same dope. And like the dope fiend, we are satisfied only by further shots of sensation, and the dreams they create. We live vicariously rather than actually.

Because of our civilization's shift toward technology, this becomes a dangerous habit–witness the public reaction to the "Martian invasion" and our belief in our own missile superiority–in each case based on "news" rather than actuality.

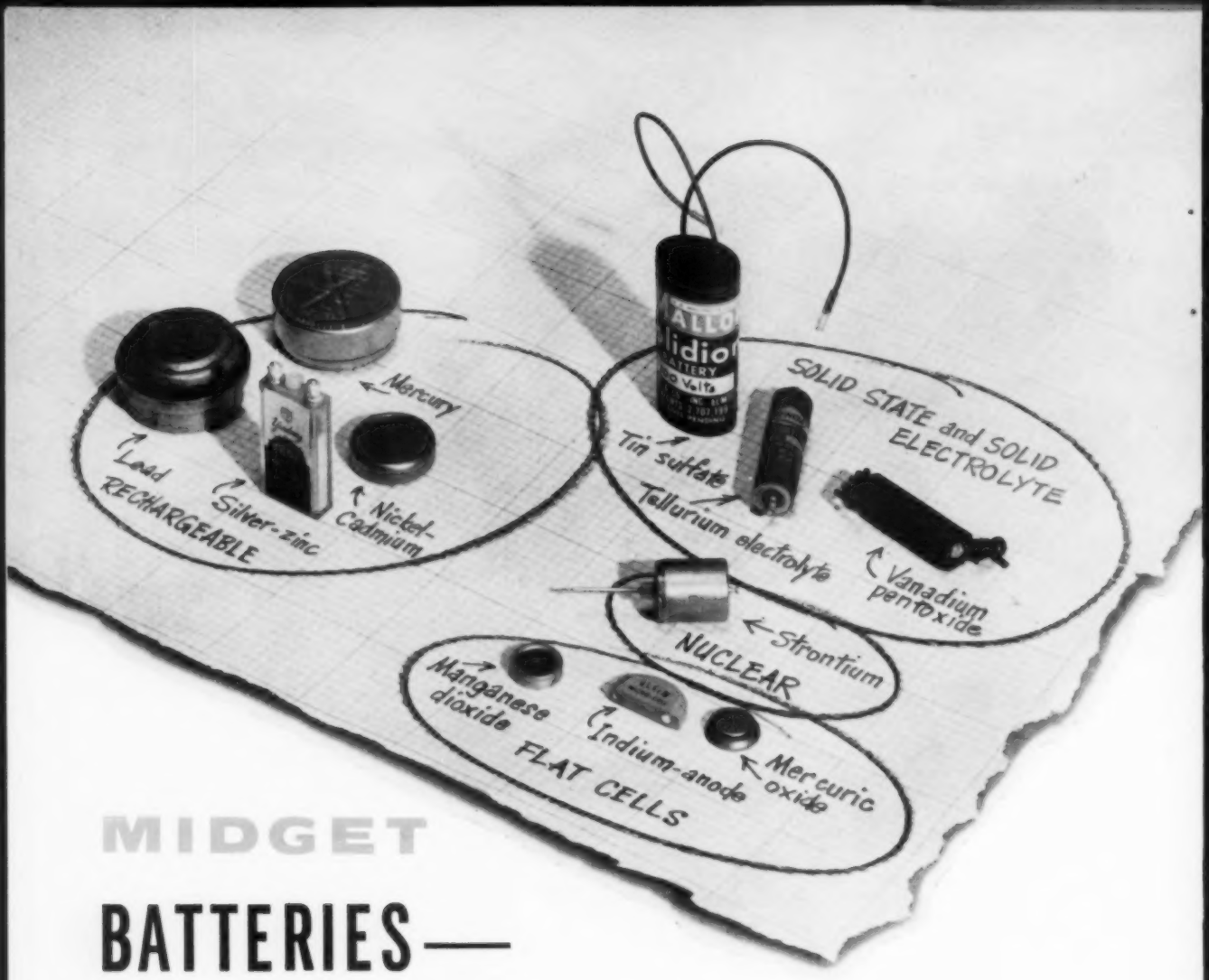
And the problem becomes even more acute when the engineer is influenced by report rather than fact. This influencing occurs insidiously and subconsciously, by the series of forecasts, plans and projects announced by various sources. Thus, when the new idea actually comes true, the edge of "newness" is gone. The danger is that the engineer, crammed with "advance" reports, will assume that the development is already old stuff.

We, as editors, are conscious of this danger, particularly because it is our job to give you the news of design, research and development in readily readable form. We try to make it interesting and informative, but without distortion or inflation. And we try further to give you an indication of what is coming–the original "news," and further reports on actual physical achievement and application.

Thus, when you read of some accomplishment reported as new, and you recall hearing of it before, better check whether it was fact you heard–or just the forecast.

Engineers, more than any other group, must shun worship of the Great God New.

T. H. Langerman



MIDGET BATTERIES—

Power Paths to New Design

Some are truly dry cells, others tap the energy of isotopes . . . all are dramatic examples of how dc power packages have been miniaturized. They're heading for many specialized applications where either current or voltage needs can be kept low.

ANNESTA R. GARDNER *Associate Editor*

Batteries that can beat Rip Van Winkle at long-term slumber and wake up ready for action . . . that pack 95 volts or 1500 ma-hr of electricity in a volume of ¼ cu in. or less . . . that can serve as timers, signalling devices, emergency cut-offs. . . . These are only a few of today's innovations. Some are already at work in such well-known products as tape recorders, hearing aids and wrist watches. Others, in the pilot stage, promise new vistas in machine and instrument design, and may extend the advantages of electric power to products that do not now use electricity at all.

Many of these new batteries—like the solid electrolyte and nuclear types—are fundamentally different from ordinary primary and secondary cells. Others simply represent progress in existing types. The tiny batteries used in Sonotone's all-in-the-ear hearing aid and Hamilton's electric wrist watch, for instance, are miniaturized mercury and carbon-zinc dry cells. But flat construction and highly refined materials pack a surprisingly large amount of power in a small space.

The indium cell, developed by Elgin National Watch Co. for wrist-watch and instrument applications (*PE*—

REPRINTED—circle 123 inside back cover

Mar 17, '58, *p* 67), resembles a standard mercury cell in that it uses a mercuric oxide cathode. But instead of standard zinc anode it has one made of indium. The substitution, says Elgin, permits designing a cell that provides essentially constant discharge voltage through its service life, and can be made 95% efficient.

Another variant on standard flat-cell construction is the wax-electrolyte battery. This uses a wax separator, impregnated on one side with zinc chloride and on the other with manganese dioxide, sandwiched between a thin sheet of zinc and a conductive vinyl film. In one experimental unit built at the National Bureau of Standards, a 25-cell, 37.5-v assembly 0.3 in. long, ¼ in. dia, and weighing 0.2 oz, has a short-circuit current of 30 microamp at normal temperatures.

REALLY DRY CELLS

Representing a new departure in battery concepts are the solid electrolyte ("solid state") batteries. These are truly dry cells which operate by diffusion of ions through a solid, rather than by movement of particles through a liquid or gas. The fact that no liquid is needed in these batteries explains their remarkably long shelf life and wide range of operating temperatures (see chart, next page). In these cells a variety of electrolytes may be employed:

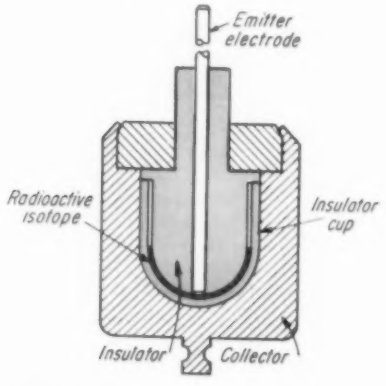
National Carbon's W-618 uses vanadium pentoxide as the cathode with silver serving as the anode, and silver iodide as the electrolyte.

P. R. Mallory's Solidon has a solid ionic conductor of tin sulfate and a depolarizer-cathode that is a mixture of barium permanganate and lead peroxide; this battery is so designed that it can be completely encapsulated in epoxy resin.

In Patterson, Moos' "Dynox 95," tellurium-treated silver bromide is the electrolyte.

POWER FROM ISOTOPES

Nuclear batteries differ even more radically from standard design. Here, a radioactive isotope is the electron source or ionizing agent. In one type, electrons from the isotope move through the dielectric and are collected by the case which serves as the cathode—action of the isotope is direct. In another type, action is indirect; radiation from the isotope strikes a phosphor screen; this, in turn, gives off light which activates a semiconductor, causing a current to flow.



Nuclear battery . . .
uses radioactive isotope as electron source. It's in contact with emitter electrode, insulated (by polystyrene) from brass collector case. This is a strontium unit, from Patterson, Moos.

In isotope batteries, action is continuous. An isotope can not be closed down or turned off. But the battery will last as long as the isotope, providing the other materials in its construction stand up.

Naturally, the advantages of these midget batteries are not gained without some sacrifices. Battery engineers point out, for example, that a solid electrolyte battery can be built which is less than 1/30 the volume of a standard D-cell, will last 20 times as long, and has 60 times the voltage. But its ability to deliver current is reduced by a factor of 10^7.

USES—WHERE AND WHEN

Right now, nuclear batteries have an additional limitation: the AEC regulations which control use of all nuclear materials. It's expected that licensing regulations will be eased for newly developed tritium and krypton units (*PE—Feb* 10, '58, *p* 7) since they use relatively safe gaseous isotopes rather than the dangerous strontium 90. Even now nuclear batteries are appearing in aircraft and ordnance equipment, ionization gages and fuse-initiating devices. The isotope batteries can serve either as direct power sources or as the "operating mechanism" of timing devices in which the continuous, controlled flow of current from a nuclear battery builds up the charge on a capacitor at a predetermined rate.

The non-nuclear batteries are not affected by such regulatory limitations. Many of them are ready right now to work in emergency shut-down units for machine tools (taking advantage of their long shelf life), portable instruments and recorders, and signalling and amplifying devices. They should make it possible to power many types of equipment where this could not be considered before.

WHAT'S AHEAD?

Looking to the future, it's hard to see how these batteries can be made much smaller, but they probably will be. Certainly their power and versatility will be increased. Already, the old lines of distinction between primary and secondary batteries are breaking down. Naval Ordnance Laboratory's lead-alkaline cell is basically a primary cell that has been given rechargeability. It uses a lead monoxide-lead anode, a potassium hydroxide electrolyte (retained in special absorbent spacers and barriers to prevent leakage), and a silver cathode. The prototype model is just over an inch in dia and about ½ in. thick, has a nominal open-circuit voltage of 0.90 v and a rated capacity of 1500 ma-hr.

P. R. Mallory is introducing a completely sealed, rechargeable mercury cell rated at 1.35 v that approximates size of the Navy lead cell, has a capacity of 2000 ma-hrs and will discharge continuously at 125 ma (*PE—Apr* 21 '58, *p* 8).

On the other hand, silver-zinc and nickel-cadmium batteries, which are basically secondary cells, are rapidly

MIDGET BATTERIES —

being reduced in dimensions to miniature primary cell size.

Sonotone, for instance, is now making nickel-cadmium batteries that are barely ½ in. in dia, and ¼ in. thick (*PE—Mar 31 '58, p 36*).

Yardney Electric Corp. has a "Silvercel" on the market that weighs only 1/7 oz, is less than 1½ in. long, yet can deliver a peak discharge current of 3 amp.

Distinctions between wet and dry cells are breaking down in another direction. There are now ammonia-activated types similar to water-activated cells, but with gas as activator, and promising longer shelf life and faster action.

Still on the horizon are such materials of construction as aluminum and magnesium. Standard-size dry cells, with manganese dioxide depolarizer but substituting aluminum for the zinc anode, have been developed; and miniaturization should be only a matter of time.

Batteries have come a long way from the standard flashlight. But they're only just beginning to show what they can do.

REPRINT of this article can be obtained for your reference file by checking No. E23 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 157.

EDITOR'S NOTE: For a review of dry cell technology and references to other articles on batteries, see "Dry Cells for Quiet, Dependable Packaged Power," Feb 17 '58, p 72.

Where to get information on:

Miniature zinc-carbon cells
National Carbon Co., 30 E. 42nd St., New York 17.

Solid electrolyte batteries
P. R. Mallory & Co., Inc., 1300 Athens Ave., Cleveland 7.
National Carbon Co.
Patterson, Moos Div., Universal Winding Co., 90-28 Van Wyck Expressway, Jamaica 18, N. Y.

Indium battery
Elgin National Watch Co., Elgin, Ill.

Lead-alkaline batteries
P. R. Mallory & Co.
Naval Ordnance Laboratory, Silver Springs, Md.

Nuclear batteries
Elgin National Watch Co.
Patterson, Moos Div., Universal Winding Co.
Radiation Research Corp., 140 E. 59th St., New York 22.

Nickel-cadmium batteries
Sonotone Corp., Elmsford, N. Y.
Electric Storage Battery Co., Philadelphia (larger sizes)
Thomas A. Edison Industries, West Orange, N. J. (larger sizes)

Silver-zinc cells
Yardney Electric Co., 40-50 Leonard St., New York 15.
Aerojet-General Corp., Azusa, Calif. (larger sizes)
Electric Storage Battery Co., Philadelphia (larger sizes)
Frank Cook, Denver, Colo. (larger sizes)

Mercury cells
P. R. Mallory & Co.
Ray-O-Vac Div., Burgess Battery Co., Madison, Wisc.

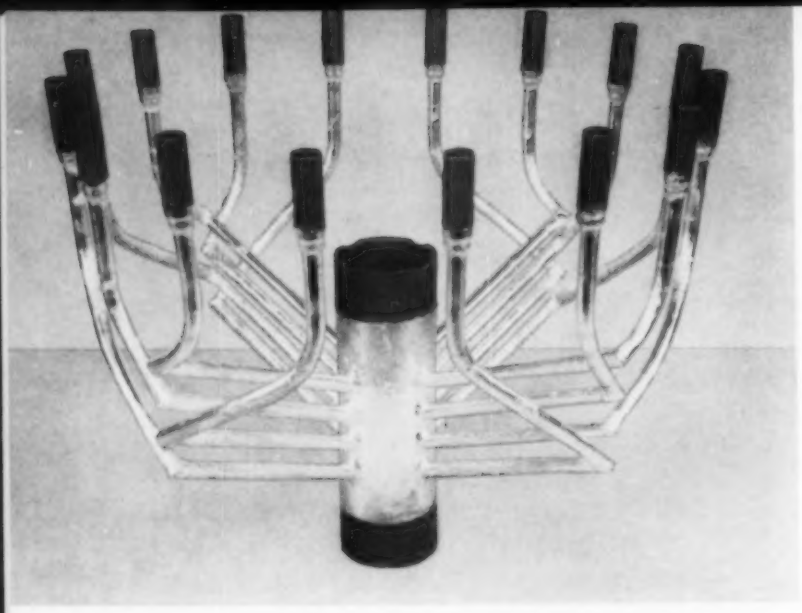
HERE ARE TYPICAL

BATTERY TYPE AND COMMERCIAL DESIGNATION
FLAT CELLS
Mercuric oxide (Mallory RM 400)
Manganese dioxide (National Carbon—W307)
Indium anode (Elgin—Micro-cell)
SOLID STATE AND SOLID ELECTROLYTE
Tellurium (Patterson, Moos—Dynox 95)
Tin sulfate (Mallory—Solidion ELS-2)
Vanadium pentoxide (National Carbon—W618)
NUCLEAR BATTERIES
Strontium (Patterson, Moos)
Krypton (Patterson, Moos)
FULLY RECHARGEABLE BATTERIES
Lead-silver oxide (Nav. Ord. Lab. XA-10E)
Nickel-cadmium (Sonotone)
Silver-zinc (Yardney—HK01)
Mercury (Mallory #4)

PROPERTIES OF MINIATURE BATTERIES

VOLTAGE	CONTINUOUS CURRENT DRAIN, per sq in. of cell area	AVAILABLE CHARGE or CAPACITY	FLASH OR PEAK DISCHARGE CURRENT, per sq in. of cell area	SHELF LIFE, 70°F	WEIGHT, oz	DIMENSIONS, IN.		OPERATING TEMPERATURE, °F	PRICE, $
						Dia	Length or thickness		
1.4	150 ma, 100 hr	80 ma-hr	250 ma	3-5 yr	0.04	0.45	1/8	25 to 125	0.31
1.5 nom.	60 μa, 1000 hr.	60 ma-hr, to 1.3 v	200 ma	>1 yr	0.05	1/2	1/8	0 to 120	1.75
1.15 to 1.37	100 ma, 100 hr	150 ma-hr	1100 ma	1-3 yr	0.13	3/4	0.2	−20 to 190	.....
95	1 μa; to 85 v, 100 hr	0.33 ma-hr, to 85 v	200 μa	>20 yr	0.395	1 1/4	3/8	−65 to 130	5 to 20
100	1 μa	.....	100 μa	>20 yr	0.6	NOTE 1		−100 to 170	5 to 50
95	0.007 μa; to 70 v, 100 hr	0.03 ma-hr to 70 v	2 μa	>20 yr	0.25	1	0.33	−70 to 170	2 to 4
5000 to 20,000	10-200 μμa	.....	.....	25 yr	0.5	0.6	1.2	−175 to 175	25 to 65
3000	40-700 μμa	.....	.....	10 yr	0.6	1 7/16	7/16	−200 to 200	5.50 to 25
0.9 nom.	0.1-30 μa	1500 ma-hr, to 0.77 v	>3 ma	>3 yr	1.5	1 3/16	0.586	−65 to 165	.....
1.3	1.35 ma, 100 hr	60 ma-hr	200-300 ma	>10 yr	0.2	3/4	1/4	−65 to 160	0.70
1.5 nom.	0.5 amp	200 ma-hr, to 1 v	3 amp	1 yr	0.1	NOTE 2		0 to 160	6
1.35	125 ma	2000 ma-hr, to 0.9 v	1.2 amp	>3 yr	1.54	1 3/16	1/2	25 to 125	2 to 4

Note 1: Rectangular case, 13/16 x 1/2, 1 7/8 long
Note 2: Rectangular case, 19/32 x 7/32, 1 3/8 long



CAST-IN

offers

- Pressure tightness
- Compactness
- Light weight

Dramatic example . . .
of the superiority of cast-in tubing. Providing these passages in aluminum casting would be obviously impractical by other methods. But casting-in candlestick arrangement of tubes (top) produced the manifold (bottom) that is about 18 in. in dia, and ready to distribute fuel for one of our missiles.

—and with these design tips it can give low-cost parts.

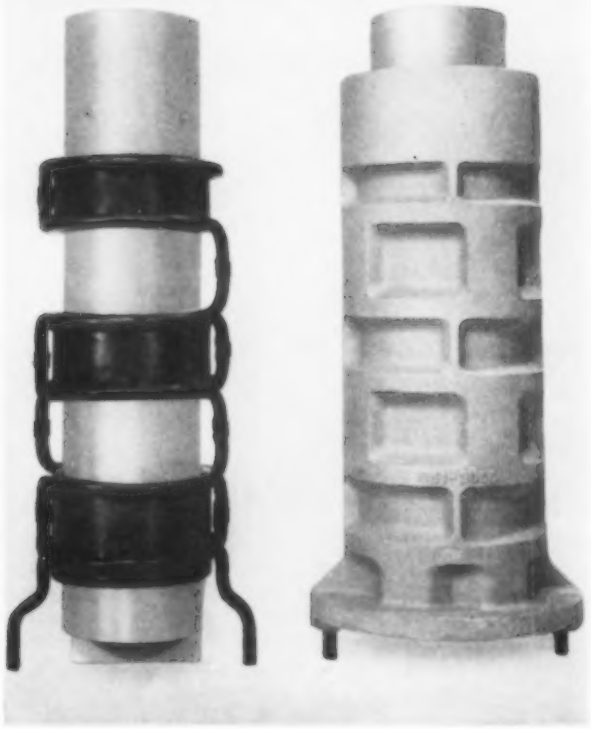
HERBERT L. KEE, *Assistant Editor*

Castings offer low cost. Tubing offers pressure tightness. Put both advantages together and you can have cheap, easily made parts that transmit fluid efficiently: their tubing is cast-in. In general, of course, tubes are like other inserts in that they raise cost of casting—because the act of placing an insert in a mold or die is an extra step that slows the casting cycle. But other considerations can reduce or eliminate the increased cost.

For example, expense is held down when castings are large, or are poured at high superheat. Such castings require longer setting times, therefore the cost caused by inserts drops proportionately.

And when finished parts are considered, they are

TUBING



Liquid cooling assembly . . .
for generator was made by welding tubes to iron rings, tacked to supporting shell. After assembly is cast in aluminum, which gives good heat transfer, shell is machined away.

often cheaper with cast-in tubes than without. In some applications, this is because of less need for machining. In others, the economy comes from turning out a one-piece casting instead of several parts, tubes and fittings that have to be assembled. Specifically, here are applications where cast-in passages for fluid will usually give such cheaper parts. The method allows:

- **Long thin holes under ⅛ in. dia.** By contrast, drilling long, narrow holes invites tool breakage; also, drilling straight holes with good alignment is difficult.
- **Complex passage shapes where the holes are curved in several planes.** Tubing eliminates need to drill from two or more points on a part and then plug off unwanted entrance holes.
- **Multiple tubes close to each other.**

. . . Besides economy in such configurations, cast-in tubes offer these over-all design advantages:

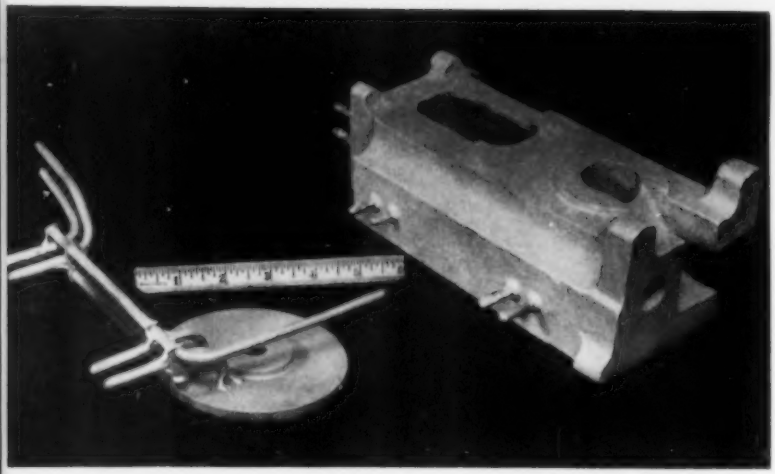
- **Smooth interior surfaces in passages.** This lowers fluid resistance; allows smaller passages, smaller parts.
- **Pressure-tight tubes** eliminate need for thick walls to insure freedom from leakage. Walls need be only thick enough to make a sound casting. This reduces weight and size of parts.
- **Multiple passages** with compound curves can be built-in without leakage from one system to another.

TUBES IN DIECASTINGS

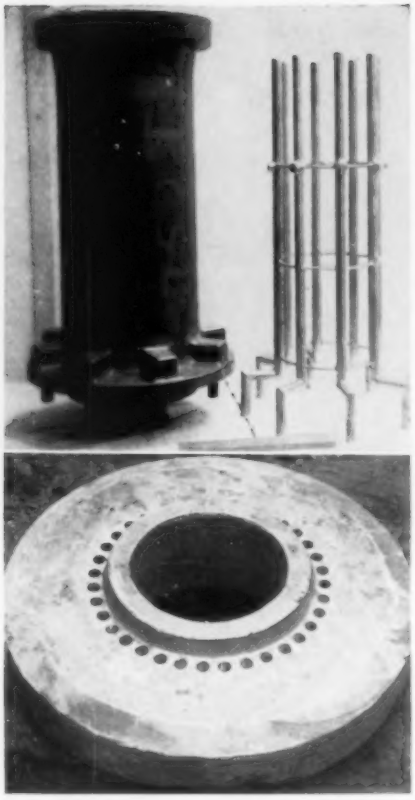
Diecastings are the cheapest form of castings, so design must be more carefully considered if cost of the finished part is to be held down. Because adding inserts interrupts the fast casting cycle, cost here is against cast-in tubing, particularly if the part can be made by staking the insert after casting, or casting with cores. But staking or coring still cannot displace cast-in tubes for long thin holes or multiple lengths of complex bent tubing. Here are design tips that will minimize extra cost:

- Consolidate tubes and inserts into as few assemblies as possible.
- Hot dies require handling inserts with heavy gloves. For speed, make inserts big enough for handling easily but light enough to be manipulated with one hand.
- Keep open ends of tubes at least ⅛ in. longer than the casting. Plugs which stop-off the tube can then also be used to position it.
- Minimum wall thickness around tubes should be about $\frac{3}{32}$ in. to give good castings. Because die castings are usually thin, walls should be rigid enough to resist flexing of tubes under pressure.
- Walls can be made slightly heavier than normal because the tubes act as chills. But avoid excessive wall thickness. This slows setting time, gives porosity, and wastes material.
- Dimension from tube to tube rather than from tube to cast edge.
- Lock short sections of straight tubing mechanically with diamond knurls to resist twisting. Also, undercut or upset the tube to resist direct pull.

Experience shows that tube sizes can range from



Two metals . . .
made this hydraulic manifold. Steel insert assembly at left combines tubes with wear-resistant pivot disk. Assembly was then cast in aluminum.



Meehanite cast iron . . .
gave these cast-in parts. Trunnion casting, top, incorporates 8 cast-in tubes, 5/8 in. ID and 1/16-in. wall. Bearing disk, bottom, has 36 1-in.-ID passages only 3/8 in. apart.

hypodermic needles to 4½-in.-dia cylinder liners. All have proved equally successful when cast-in.

There is also a wide range in materials suitable for tubes—from brass and copper, to steel and stainless steel, to nickel-base alloys such as monel and Inconel. Tube assemblies can either be welded or brazed before casting in.

Zinc die-casts at twice the rate of aluminum, so any interruption in the casting cycle is more costly. Its lower melting point makes it easier to cast but the parts cannot be used at elevated temperatures, nor can tubular sheathed heating elements be cast-in. Also, zinc corrodes unless protected. On the other hand it has higher room temperature strength and hardness, can be cast in thinner sections, and is more rigid in these thin sections.

Aluminum die castings cost less in material for a given volume, do not need additional finishing for corrosion protection, have higher heat conductivity when heat transfer is needed, and can be used at elevated temperatures up to 400-500 F.

TUBES IN ALUMINUM

Tubes cast in aluminum parts fall into two categories —bonded and unbonded. Casting around precoated tubes metallurgically bonds them to the cast metal, and presents slightly different design problems.

Tubing material is limited to steel, stainless steel and some nickel alloys like Inconel. Copper, brass, or monel tubing dissolve rapidly in molten aluminum, so cannot be used.

Tube assemblies must be either welded or brazed at high temperature with a material like Nicrobraze. If Nicrobrazed, a dry flux must be specified.

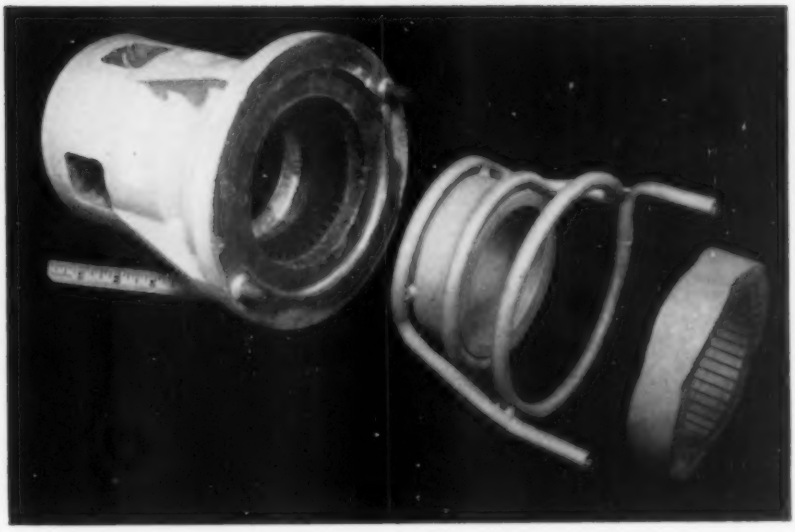
High conductivity of aluminum makes it suitable for casting-in sheathed heating elements like Calrods. This conductivity around the heating element distributes heat evenly. While bonding elements promotes heat transfer, it may not be warranted where efficiency is not critical as in electric irons.

Maximum wall thickness is not limited as in die-castings. The molten metal should solidify on the tube first so that the aluminum will shrink around the tube rather than pull away from it.

Minimum wall thickness around bonded tubes should be ⅛ in. although casting sections can be thinner if the gating allows hot metal to flow between tubes and past them. Unbonded tubes which are not wetted by the molten aluminum should have a minimum section of $\frac{3}{16}$ in. Otherwise aluminum will misrun or form porosity next to the tubes.

Filling the mold is done gradually rather than instantaneously as in die-casting. Large tube bundles will be heated unevenly by the rising level of metal in the mold. Spiral or helical-shaped tube assemblies which expand, unwind, and distort when cast should be avoided.

Accurate tube-to-tube dimensions of 0.010 in. per



Dc conversion . . .
to ac occurs inside this alternator housing of aluminum, which has cast-in cooling coil and stator laminations.

in. can be kept if the tubes are held rigidly to each other by welding.

When to bond is determined by final use of the part. Where the joint between tube and casting has to hold high pressures, bonding must be specified–to prevent leaks. It also gives better heat transfer, and adds mechanical strength without mechanical locks which raise stresses; allows aluminum to be metallurgically welded to ferrous alloys; and in lightweight assemblies can combine high strength of steels with the light weight and rigidness of thick aluminum sections.

TUBES IN CAST IRON

Casting tubes or pipes in cast iron is more complex, because steel or iron pipes melt at the pouring temperatures. Although problems differ with each shape and materials, these basic rules apply:

Tubing or pipe is limited to steels or stainless steel. Steel pipe with copper plating is preferred because copper does not react with molten iron. Yet, it prevents formation of rust which would have to be cleaned off, and embrittlement of the pipe through absorption of carbon from the cast iron.

The tube assembly should be welded into one piece, because fittings may leak molten metal which seals off tubes. However, if fittings are used, specify steel ones, not cast iron.

Wall thickness of pipes depends mainly upon cross-section of poured metal. The general relationship is:

Casting Cross-section, in.	Pipe Wall Thickness, in.
1 or smaller	$\frac{1}{8}$
1 to 2	$\frac{5}{32}$
3 to 4	$\frac{1}{4}$
4 to 8	$\frac{3}{8}$

These sections are given for Meehanite metal, a special form of cast iron which is poured above 2500 F. For normal gray cast irons poured at 2300 to 2400 F, the recommended cast sections are somewhat larger.

Minimum wall thickness of tubing is $\frac{1}{8}$ in. because lighter tubing would warp and float away from desired placement unless special precautions are taken.

Maximum section of cast metal is limited because excessively long solidification time allows molten metal to dissolve tubes. If sections are unusually heavy, tubes can be cooled internally with air, or the metal can be poured at a lower temperature.

Chilling from pipes or inserts may crack or form brittle white iron. To avoid these troubles, choose cast iron with a low modulus.

To promote heat transfer, bonding is recommended for heating elements. Here, it is important to have progressive solidification of the cast iron so that it will shrink around the tube.

EDITOR'S NOTE: Other recent articles on fluid circuits include: "Maintenance Advice for Fluid Circuits," Mar 17 '58, p 71. This checklist covers the principles—preventive and trouble-shooting—that will keep hydraulic equipment working properly.

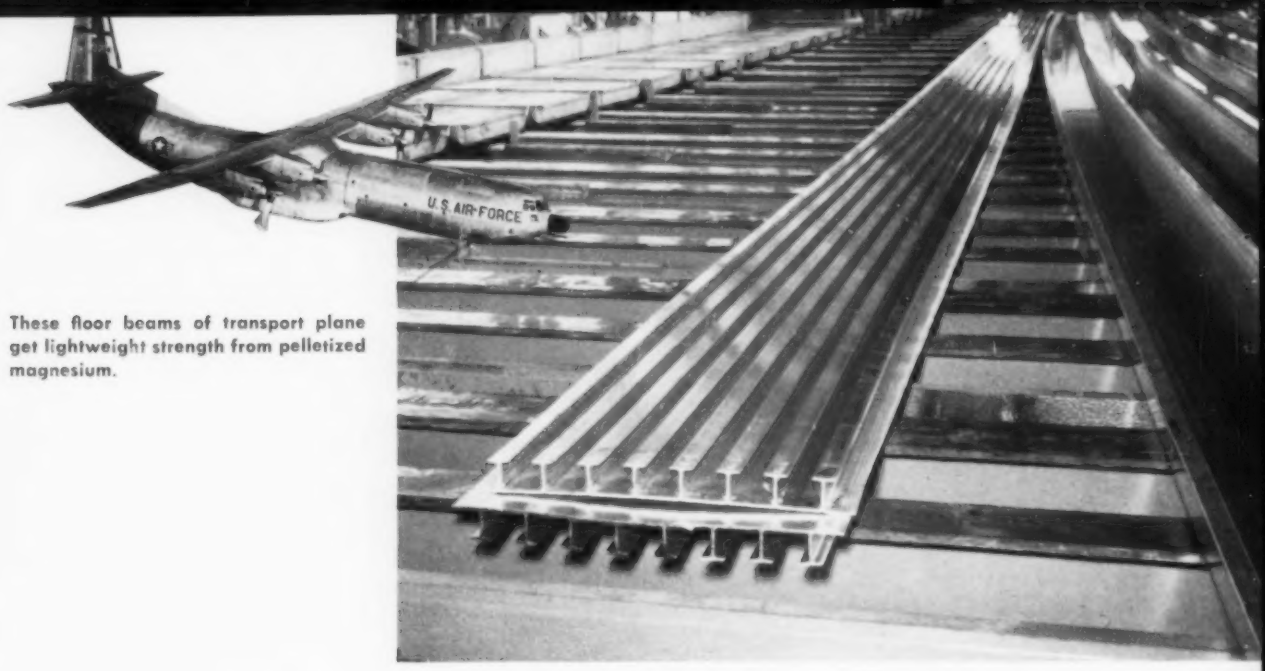
"Sandwich Manifolding," Feb 17 '58, p 88. When hydraulic circuits become a maze of tubing and fittings, simplify systems and connect components through built-in manifolds.

"How Much Horsepower to Pipe Liquids?"—Jan 6 '58, p 89. Charts give answers for flow from 50 to 100,000 gpm for varying pipe roughness.

"Metal Hose," Nov 11 '57, p 87. Discusses strength, leak-tight service, and flexibility of various types of metal hose.

"Higher Pressures for Mobile Hydraulics," Oct 28 '57, p 60. The 3000-to-6000 psi circuits offer a lower-cost answer in many applications.

Acknowledgement: Information helpful in preparation of this article came from: Al-Fin Division, Fairchild Engine and Aircraft Corp., Deer Park, L. I., N. Y.; Gray Iron Founders' Society, Cleveland; Dollin Corp., Irvington, N. J.; Meehanite Metal Corporation, New Rochelle, N. Y.; Die Casting Research Foundation, New York City.



These floor beams of transport plane get lightweight strength from pelletized magnesium.

PELLET EXTRUSIONS Beef Up Magnesium Structures

Although they now cost more than regular extrusions, their compressive strengths promise radical design changes for large magnesium sections.

G. S. FOERSTER
Metallurgical Laboratories
Dow Chemical Company

H. A. JOHNSON
Light Metals Section
Wright Air Development Center

Strong, lightweight extrusions are now being made from tiny magnesium pellets— in somewhat the way a master baker squeezes powdered-sugar frosting from a decorating tube. Unlike the methods of powder metallurgy, this process needs no compacting or sintering steps. Yet it gives structural shapes that have 15% to 40% higher compressive yield strengths than those shaped from billets of the same metal. Result is stronger, lighter components such as the support beams, shown in photo above, for floor and built-in loading ramp of the C-133 transport plane.

. . . To make the pellets, which average 0.016 in. diameter, molten magnesium is sprayed through an orifice onto a disk spinning in an atmosphere of natural gas. Centrifugal force disperses the metal into small droplets. These solidify and are blown to a screening station where over-size pellets are removed.

. . . To extrude the pelletized material, they are again moved pneumatically. First they are preheated. Then they are blown through pipes into the chamber of an ordinary extrusion press—from which they are extruded through a die that gives the desired shape.

Future for the Process

The new method is still relatively expensive. Last year's production totalled 27,000 lb. Because of the price, 50% over that for regular extrusions, applications to date have been limited to military customers.

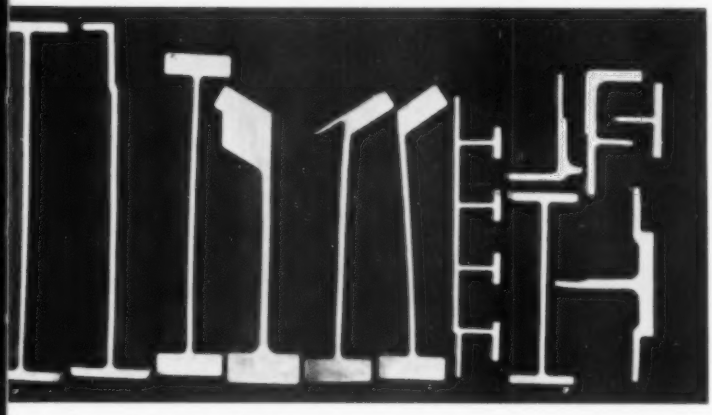
But the method is potentially cheaper than standard extrusion because of the uncomplicated efficiency with which the pellets can be moved automatically. Moreover, the process can conceivably be adapted to give continuous lengths of extrusions—which can then be chopped off to order—as with ceramics and plastics.

Smaller Grain—Stronger Parts

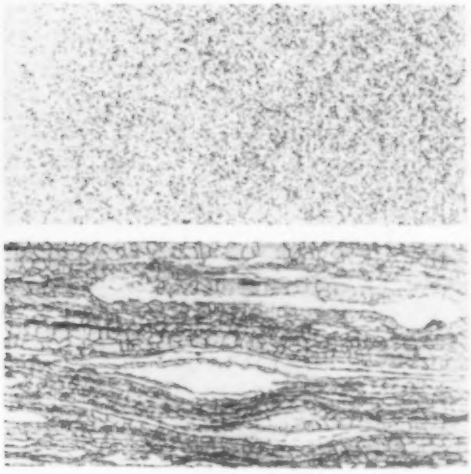
Mechanical properties of the pellet extrusions, especially compressive yield strength, are substantially higher

Minimum Mechanical Properties

Cross-section, sq. in.	ZK60A-T5 (BILLET) Strength, 1000 psi Ultimate Tensile	Tensile Yield	Compressive Yield	Elong. %	ZK60XB (PELLET) Strength, 1000 psi Ultimate Tensile	Tensile Yield	Compressive Yield	Elong. %
Up to 2	48	36	30	4	45	35	35	4
2 to 3.5	46	36	28	6	45	35	35	4
3.5 to 10	46	36	25	6	45	35	35	4



Variety of shapes . . .
is not limited when extrusions are made by the pellet process. Examples are these structural shapes. Tallest one is 10 in. high; thickest section is 2 in.



Uniform fine grain . . .
explains why pellet extrusion, top, (enlarged 250X) has higher strength than ingot extrusion, bottom, with nonuniform structure.

—without a lowering in such other properties as machinability, formability, corrosion resistance and level of fatigue strength. This is because of the small grain size. In conventional extrusions the compressive yield strength is noticeably lower than the tensile yield because of the mirror-image defects in crystals formed under compression. Such "twinning" is inhibited as grain size decreases.

Works with All Mg Alloys

Although any magnesium alloy will give a pellet extrusion, ZK60XB (6 Zn, 0.6 Zr) was selected as the first commercial product because of its combination of high strength and toughness. Many conventional extrusions have been made from essentially the same composition ZK60A (5 Zn, 0.6 Zr) to take advantage of its high strength. Comparison of the mechanical properties of both types of ZK60 extrusions is made in the table at top of this page and shows an over-all advantage for the pellet method.

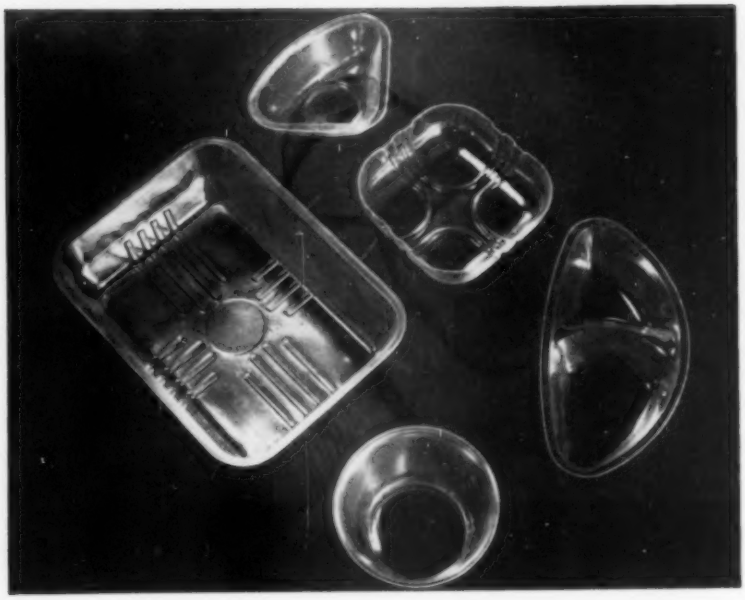
Increasing the cross-section of conventional ZK60A-T5 decreases the compressive yield strength, but has no effect on pellet extrusions. Large shapes can therefore be made with much improvement in properties. For example, minimum compressive yield strength of a 10-in. I-beam with cross-section of 4 sq in. is increased 40%—from 25,000 psi to 35,000 psi. Pellet extrusion of small shapes with section under 2 sq in. shows less increase in strength but substantial enough to justify considering redesign of existing parts.

The fine grain in pellet extrusions is readily apparent in photomicrographs. Normally, ZK60A ingots must be heavily worked by extrusion to produce fine grain uniformly throughout the part. If the shape is too large, the cast structure is not completely refined. Pellets, on the other hand, already have a fine grain comparable to that of a high-reduction extrusion. Further refinement of the pelletized magnesium during extrusion gives smaller grain and even higher strength.

EDITOR'S NOTE: Other articles on designing lightweight high-strength structures:

"High-integrity Aluminum Castings," Feb 17 '58, p 69. Practical experience helps choose the right alloy, strengthen critical areas and appraise foundry techniques for specifying reliable castings.

"New Aluminum Forging Alloy," Dec 23 '57, p 62. Alloy 7079 has low notch sensitivity and is especially suitable for thick sections requiring high strength.

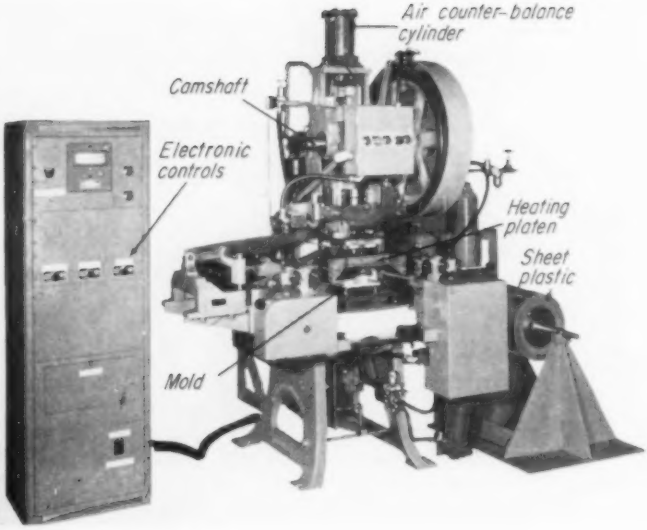


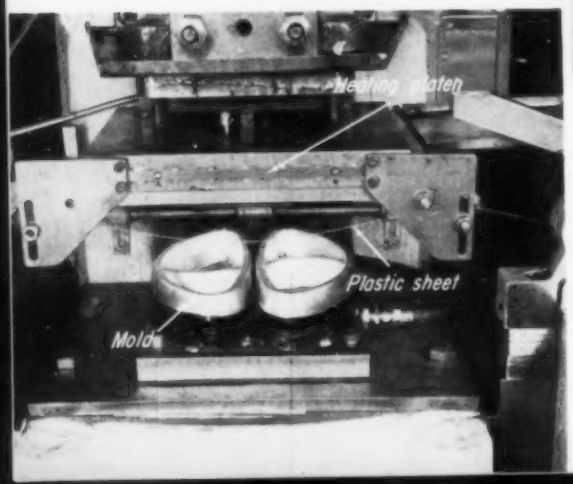
Trapped-sheet forming . . .
enables machine to reproduce in plastic the fine detail engraved in the molds. Parts made this way may have flanges, or the flanges can be sheared when the cam drives the slide through blanking position. Maximum part size is 9x11 in. with draw depth of 3 in. Forming speeds are usually 15 to 25 cycles per min.

Redesigned Press Molds Plastic

A cam instead of a crank now moves the slide of a press redesigned to pressure-form sheet plastic.

After developing Polyflex, a biaxially oriented polystyrene, the Plax Corp., subsidiary of Emhart Mfg. Co., needed a new forming machine to take advantage of the material's properties. Plax turned to Emhart's Central Engineering Dept., which decided quickest way to develop the new machine would be to modify an available punch press made by the V & O Press Div., Hudson, N. Y. The new forming and blanking machine is called the EM-134.



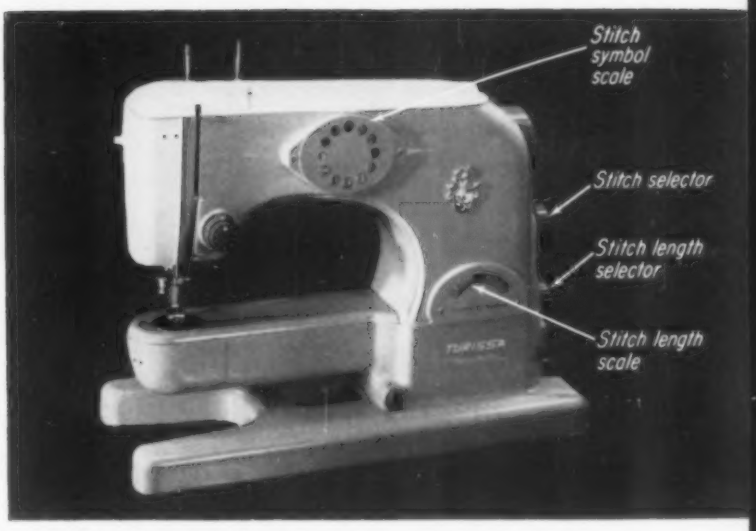


Cam-driven slide . . .
first clamps edges of the sheet to prevent shrinkage during subsequent heating. Compressed air is then blown into the mold, forcing the sheet upward against a platen that heats it to 250 F for forming. Next, compressed air blows through ducts in platen and forces sheet down into the mold cavity. A mechanical knockout lifts parts from mold so they can be discharged from machine by compressed air. The machine has a 3¾-in. cam stroke, and the slide is stopped at top and bottom stroke positions. An air counterbalance lifts the slide on the up-stroke; electronic controls monitor heater temperatures and sequence each step of the forming cycle.

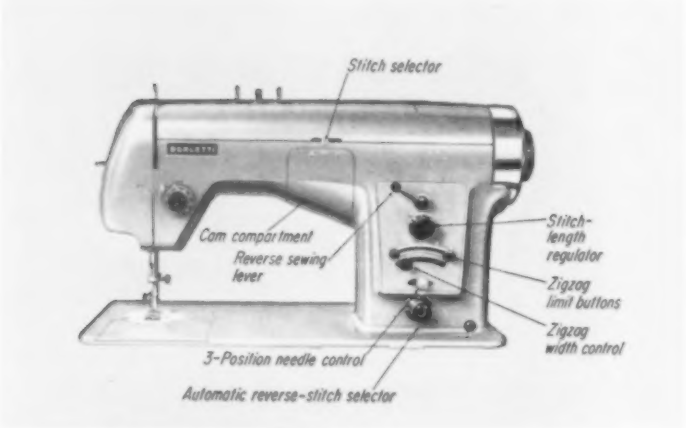
Versatile versus Portable

What's a better automatic sewing machine? That depends. A Swiss design emphasizing preset patterns has only two control knobs, weighs 35 lb including carrying case. An Italian model, for homework, has more controls—but they allow a multitude of sewing patterns.

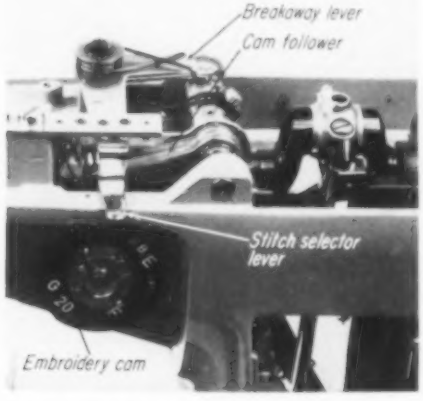
The 2-knob machine is the Novomatic made by Turissa Nahmaschinen Ag in Zurich. It features semi-automatic sewing of buttonholes, also offers customary cam-controlled fancy stitching. The nonportable machine, for heavier work at home, is made by Borletti Co. of Milan, and is called Model 1201.



Simple operation . . .
of the Turissa Novomatic results from transmitting knob motion through gears and chains. One knob selects straight sewing, zigzag sewing in 3 predetermined widths, and 5 ornamental stitches. Second knob controls stitch length. Less space is required for rotary control motions than for levers and links. All ornamental stitches are controlled by cams. The selected stitch symbol is positioned under a red window in telephone-dial-like indicator. Additional sets of stitches are provided by auxiliary cams and symbol disks that interchange with those in the machine. Feeding is by two triangular eccentrics that lift cloth and move it past the needle.



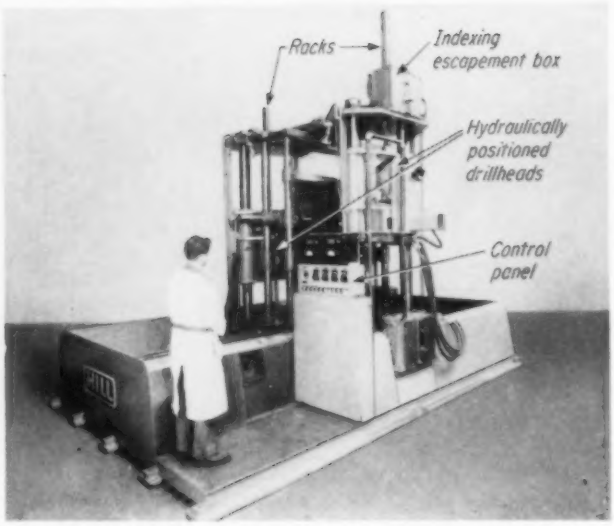
Three basic stitches . . .
are provided by cam-controlled mechanism of the Borletti 1201; they are embroidering, zigzag and straight stitching. Controls on rear column of the machine select forward or reverse stitching, regulate stitch length, set width and side limits of zigzag stitching, and control needle position and automatic reverse stitching. Basic pattern is selected by 3-position lever over the cam compartment. Although the operator can introduce infinite variety into the patterns, results of any setting are known only by experiment or experience. A design feature is the double-acting spring-breakaway action in lever system that selects the basic stitch by moving a follower from one cam to another. Operator moves control directly to proper detent, but the follower waits until cam positions let it be pulled into place by the double-acting spring.

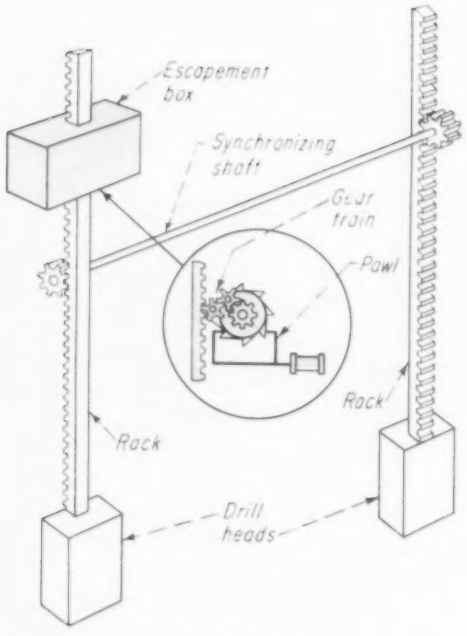


Drills Obey Escapement

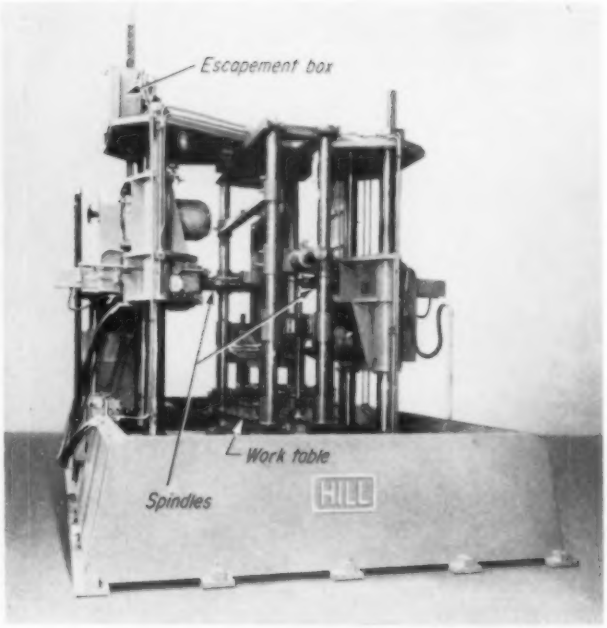
In this indexing operation, a hydraulically actuated pawl releases escapement that controls two racks also powered hydraulically. Racks position pair of drilling heads on machine that puts holes in tubesheets.

Positioning system also moves worktable. Machine was designed by Walter P. Hill, Inc., Detroit, to produce hole patterns in tubesheets and boffles for heat-transfer equipment. It handles work up to 6 ft dia and 10 in. thick; drills holes in 1/20 the time previously required.

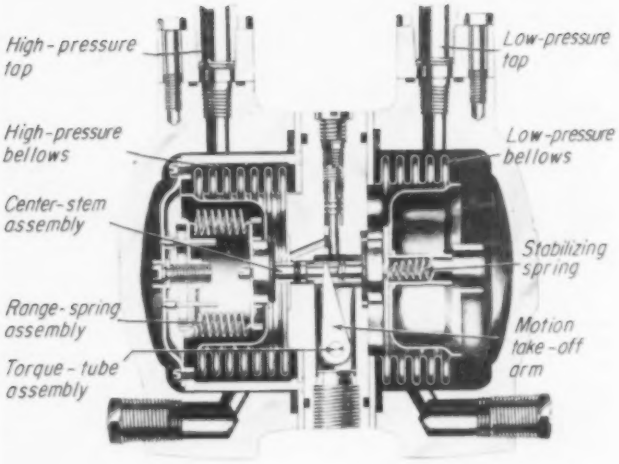


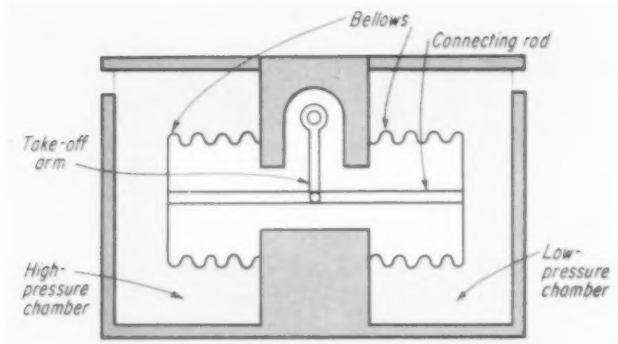


Heads are indexed . . .
to next row when electric controls actuate a hydraulic cylinder that releases the escapement wheel in the head-positioning mechanism. This lets other hydraulic cylinders, one under each drill head, raise and lower the heads in unison. A connecting shaft and pinions keep them synchronized. Hole spacing is varied by changing gears in escapement mechanism.



Hydraulic-powered heads . . .
on each side of machine move drilling spindles up and down 6-in.-dia. columns. The heads produce 18,000-lb thrust and carry 4-in.-dia spindles driven by 15-hp motors; each spindle has a 4-speed drive. Fixture that holds the work is on a table moved longitudinally by hydraulic cylinders. Drilling heads are opposed to increase accuracy by balancing cutting forces. They drill two horizontal rows of holes simultaneously, then index for the next two rows in the preset pattern. Worktable travels 15 ft so fixture can be loaded out of the working area; heads move 36 in. vertically, spindles 12 in. horizontally.





TYPICAL EQUAL-DIAMETER BELLOWS DESIGN

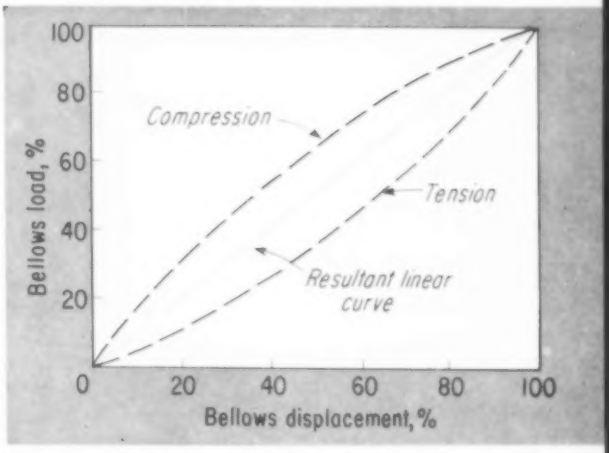
Bellows of different diameters are used in this differential-pressure meter that compensates itself for temperature and pressure changes. Range springs and torque tube are made of a constant modulus alloy.

This dry-type meter body converts differential pressure into angular position of an output shaft that operates a recording, indicating or transmitting instrument. Major features include high output torque and nearly linear damping of pressure pulsations. Meter is made by Brown Instruments Div. of Minneapolis-Honeywell Regulator Co., Philadelphia.

Unequal-diameter bellows . . .

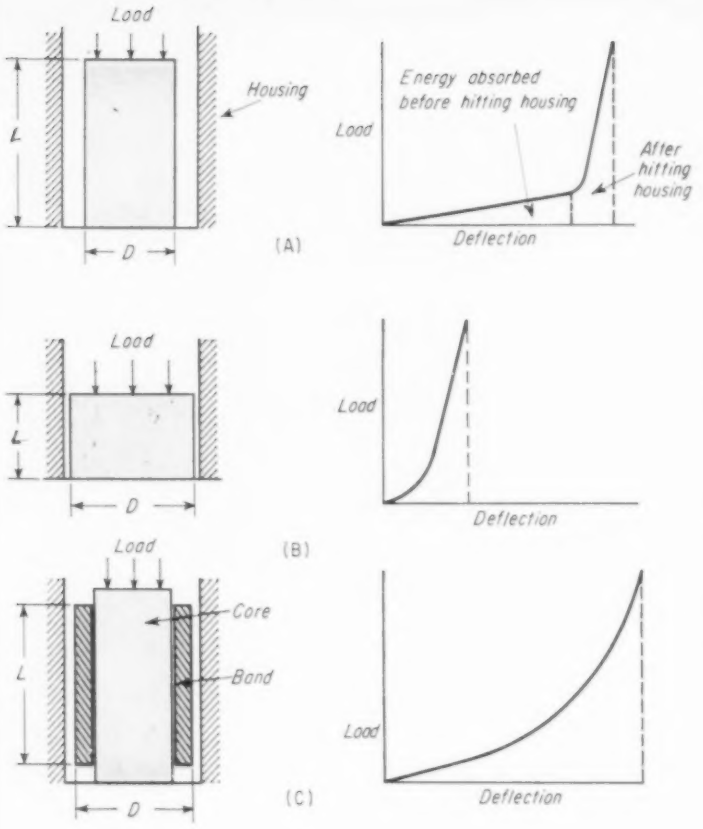
work in conjunction with a stabilizing spring to compensate for changes in temperature and static-pressure. Meters of this kind have a fluid fill in the space between the bellows to prevent damage from overpressure. In designs with equal-diameter bellows (see diagram), an expansion chamber was required because the bellows were connected by a rigid rod.

In the new design (cut-away view), bellows are connected by a stabilizing spring so designed that fluid volume changes are absorbed by expansion of the low-pressure bellows. This expansion stretches the spring and its increased tension offsets increased pressure on the high-pressure bellows. The high-pressure bellows and the output shaft therefore do not move.



Linear output . . .

is obtained although each bellows has a slightly non-linear characteristic. This results from stressing the low-pressure bellows in tension and the high-pressure bellows in compression, an arrangement that lets the non-linearities cancel each other. Meter uses seamless steel bellows. Output motion is transferred to the instrument mechanism through a shaft and torque tube.



Configurations . . . of absorbing devices influence spring rate characteristics. Rate for rubber bar in (A) is too low until bulging bar hits housing wall, then rate rises too sharply. A larger core (B) only reduces energy capacity. Spring rate is still too sharp. Core-and-sleeve method (C) has smoothly rising rate and high energy capacity.

high loads can't bulge rubber spring in this . . .

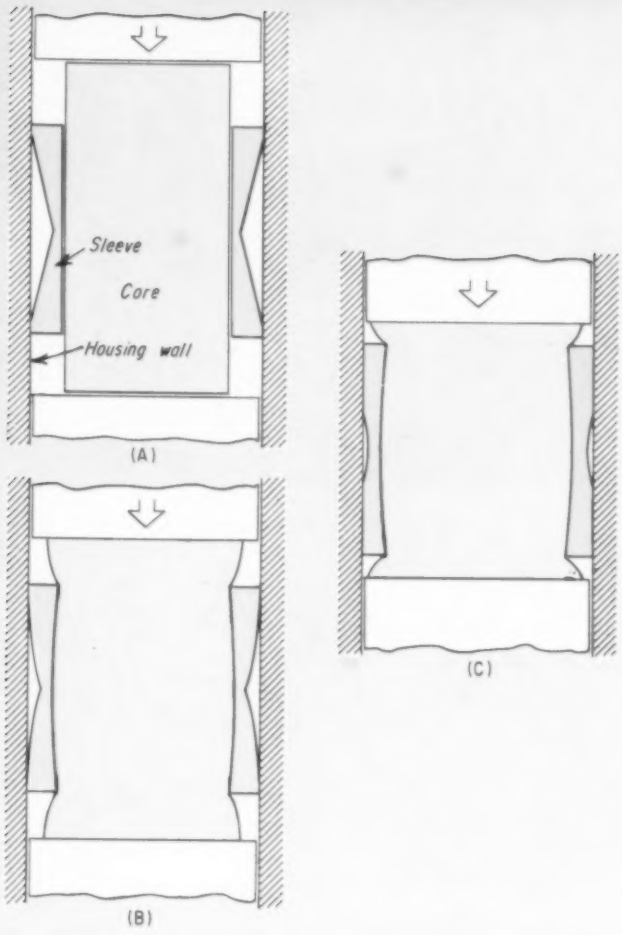
Both the load-absorbing core and its restraining girdle are silicone rubber. They give smooth spring rate plus high energy-absorption ability. Author provides procedure for determining correct size and configuration.

Laboratory experiments have paid off in a new shock-absorbing device that is now at work under demanding conditions. It requires a minimum of operating space, yet will take on both a steady-state load and an intermittent shock load. Outstanding feature of the two-part device is its smoothly rising spring rate. A rubber material is used for both the solid core that undergoes deflection, and its girdle—shaped like a shallow V—that prevents the core from excessive bulging under load or shock.

Silicone rubber is used in present design because of its suitable characteristics over a wide range of temperatures. The type selected has a durometer hardness of 50 ± 5. Parts are made in a split mold and cured under pressure. The shock absorber has been incorporated in airborne radar equipment and has a promising future in many other applications such as vehicles and machine tools.

The radar application shows value of the device. Here, it is subjected to constant load from the hydraulic drive actuator and to dynamic load from the mass of the antenna. Many helical spring designs were considered. But for the space allowed, the loading could not be absorbed without the spring failing in torsional shear. Moreover, volume-to-load ratio of helical springs is high.

Hydraulic springs were next considered. But the wide range of temperatures to which the system would be



Deflection . . .
of new-type shock absorber during loading: (A) unloaded condition—area above sleeve is free to expand laterally; (B) lightly loaded condition—V-type sleeve flattens while restraining belly of core; (C) maximum loading—spring rate has been climbing smoothly and most of outer sleeve surface now contacts wall.

ABSORBER

R. M. SANDO, *Fellow Engineer*
F. E. ENGLAND, *Associate Engineer*
Air Arm Div., Westinghouse Electric Corp.

exposed would change viscosity of the hydraulic fluid. Therefore, large variations in the spring rate or in other characteristics would occur. Sealing problems were another drawback to using a hydraulic energy-absorber.

A solid bar of rubber also would not meet requirements. It bulges too easily under load; hence has both a low spring rate and a low load capacity until the bar is expanded sufficiently to press against the housing —then the spring rate becomes too high and the total energy absorbed becomes small. Making the bar diameter almost as big as the housing would only cause a sharply increasing spring rate without increasing the energy capacity. In fact the energy capacity would be less because the rubber can only take a limited load.

Solution—Core and Sleeve

The method decided upon—girdling the core with a restraining sleeve causes compression in the core, and hoop tension in the sleeve. Tests showed that a V-shape sleeve gives smooth performance by causing the core, as it expands under pressure, to fill its housing more uniformly. Net result is a smoothly rising spring rate with high energy capacity.

The spring rate can be varied to meet the exact requirements of the application by either employing a different material for the core than for the sleeve, or by varying the cross-section of the sleeve.

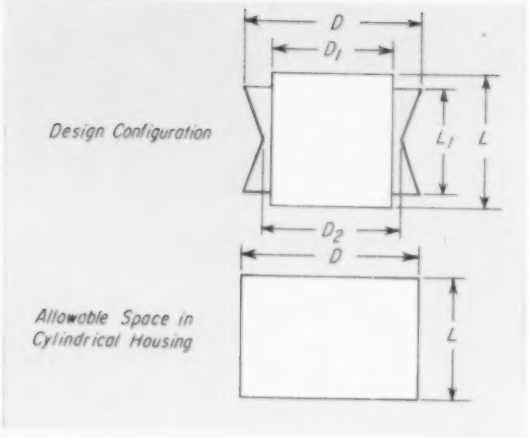
In development, prototype units were evaluated with an compression testing machine. Loads were applied to the plungers on the shock absorber housing, and a dial indicator measured the corresponding deflection.

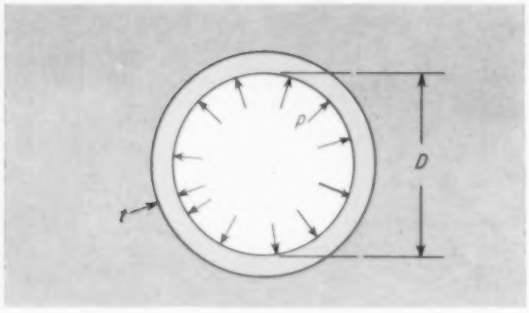
Design Procedure

First step is to approximate the over-all dimensions of the shock absorber by using this equation:

$$F_m = F\left[1 + \sqrt{1 + \pi D^2 EU / 2LF^2}\right]$$

SHOCK ABSORBER





which can be transposed to give the L/D^2 ratio:

$$\frac{L}{D^2} = \frac{\pi E}{2F^2}\left(\frac{U}{\left(\frac{F_m}{F}-1\right)^2-1}\right) \qquad (1)$$

where:

L = over-all length of absorber, in.
D = over-all dia of absorber, in.
E = Young's modulus of absorbing material, lb/sq in.
F = steady-state load, lb
F_m = max force that can be imposed on the housing, lb
U = shock energy to be absorbed, in.-lb

The values for E, F and U are known by the existing or imposed conditions of the problem. Force F_m is limited by thickness of the cylindrical housing t and the tangential stress S. Thus, using the equation for a thin-wall cylinder:

$$S = \frac{pD}{2t} = \frac{F_m}{2\pi Lt}$$

And the max force that can be imposed becomes:

$$F_m = 2\pi LSt \qquad (2)$$

The cylinder is so designed that tangential stress is well below yield stress of the material, and that the smallest practical thickness is employed. This will give a range of L and D values that will satisfy both Eq (1) and (2). The limiting factor may well be the shape of the space available. Also a rough approximation of the spring constant K of the absorber can be obtained by using this equation

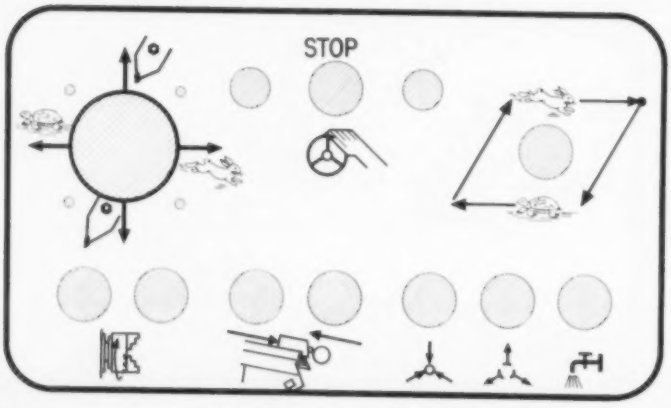
$$K = \frac{\pi D^2 E}{L}$$

Next step is to determine dimensions of the sleeve and core, using these empirical formulas developed from a series of tests:

$$L_1 = 0.75\,L$$
$$D_1 = 0.70\,D$$
$$D_2 = 1.12\,D_1$$

These three equations will lead to a sleeve configuration that, under load, will flatten against the housing without becoming overstressed.

FUNCTIONAL SYMBOLS for MACHINE TOOLS



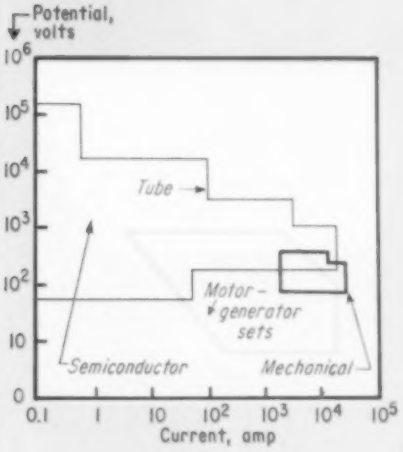
All machine tools designed for export at H. Ernault-Batignolles, Paris, are now equipped with control panels having functional symbols (tortoise for SLOW, flowing spigot for VALVE, etc.) conforming to recommended standards issued by AFNOR, the French equivalent of our American Standards Association.

About 50 panel designations common to machine tool control are listed in ISO/TC 39/GT3 (France-1) 61. This standard will be discussed at the annual ISO meeting at Harrogate, England, June 9-21, as the next step toward world-wide adoption.

GERMANIUM and SILICON take the lead among... SEMICONDUCTOR RECTIFIERS

Comparison tells the story. Both materials often cost less than their selenium or copper-oxide rivals, as well as tube, motor-generator and mechanical rectifiers. Yet they perform as well or better.

1 Typical performance ranges for assembled rectifiers. Silicon and germanium are already competitive with selenium and copper oxide in most of tinted area: and silicon can now compete with tubes at very high voltage.



RAYMOND A. YORK, *Mgr., Rectifier Engineering*
Semiconductor Products Dept., General Electric Co.

Of all rectifiers, semiconductors are the simplest. Their compact, crystalline junctions provide direct current without moving parts, tube filaments, or triggering devices. Copper oxide and selenium, for example, have dominated the field for years. And now there are silicon and germanium—the former for higher voltages, the latter for lower ones. Mass-produced and dependable, they usually can meet or better the performance and economy of any other commercial rectifier—and in a fraction of the space.

This is not magic . . . it is the cumulative effect of higher efficiencies and higher current densities. Both semiconductors also resist reverse-current leakage at higher potentials; both, because of extreme compactness, require less cooling; silicon will withstand higher temperatures than any previous semiconductor rectifier.

Why then haven't germanium and silicon rectifiers displaced all other forms? One reason is they need time to prove themselves. And there are some limitations. Their small size means low heat capacity, hence poor ability to absorb excess power quickly during a surge of current or voltage. Also, there is a danger point not too far above maximum current, temperature or potential (peak reverse voltage). Here reverse currents increase rapidly, and if not limited will reduce electrical resistance drastically . . . the semiconductor no longer rectifies. Protective devices (such as very fast fuses) are required, unless there is assurance that the rectifier rating will not be exceeded.

Selenium and copper-oxide units have "softer" (more gradual) breakdown characteristics that tolerate higher-than-peak reverse potential, high current, and high temperature for a short while without failure. Also, their bulkier design means they can absorb some excess heat.

CHOOSING A SEMICONDUCTOR RECTIFIER

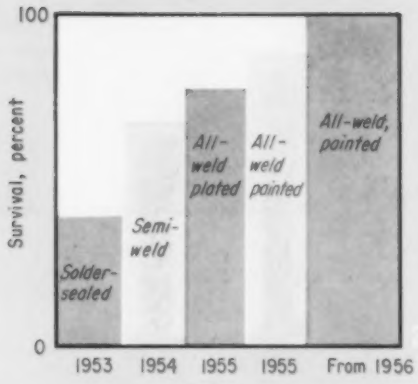
The accompanying tables and charts compare available semiconductor materials and actual rectifiers, and give tips for successful operation.

Peak reverse potential (usually called "peak inverse voltage") refers to the maximum ac value (in direction opposite to normal current) which a single rectifying junction can tolerate continuously without short-circuiting or otherwise breaking down. Values assigned are at discretion of manufacturer. A recommended minimum test (for each cell) is to apply 125% rated voltage plus 25 v . . . under these conditions there should be no abnormal increase in reverse current.

There are three degrees of failure in service: slight overvoltage increases reverse current without permanent damage; higher voltage and current permanently lower reverse resistance enough to warrant later replacement of cell; and excessive voltage can trigger a catastrophic "thermal runaway," a problem described below.

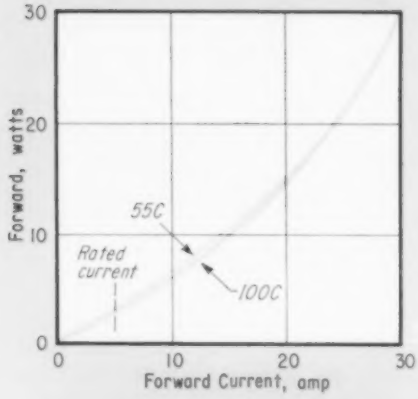
Rectifiers in series, if carefully matched, tend to protect each other. That is, reverse voltages higher than stack rating will increase reverse currents in one or more cells, but the remaining cells will limit current to prevent catastrophic failure.

Aging (increase in forward resistance) does not occur in germanium or silicon. If made properly, unstable



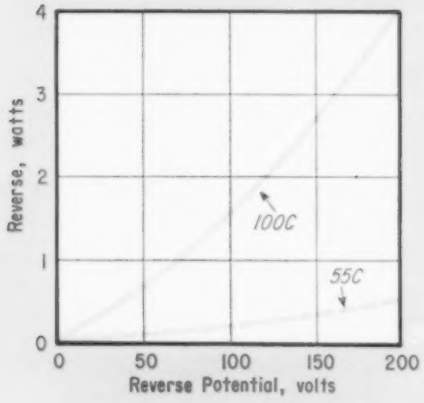
2 Rapid progress . . .

since 1953 in survival of germanium rectifiers—based on accelerated 5000-hr test at max rating. Normal life will be many times greater than this for both germanium and silicon.



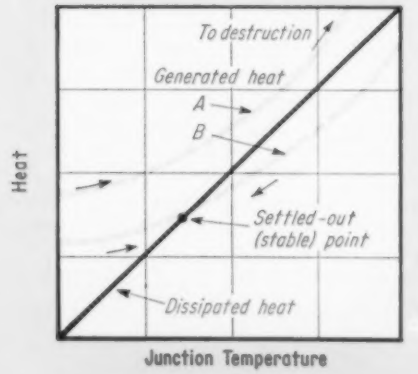
3 Heat generation . . .

in typical 5-amp germanium rectifier is a measure of power loss. Special dc test pulses were applied in forward direction (a) and reverse (b). Excessive total heat causes sudden failure of rectifier.



4 Thermal runaway . . .

of germanium or silicon rectifier will occur when generated heat is greater than dissipated. Rectifier A will runaway at any temperature: rectifier B will "settle out" to safe, constant temperature because heat-dissipation increases faster than losses.



imperfections and excessive foreign impurities do not exist, and nothing can wear out. If made improperly, failure is unpredictable and sudden. For example, an impurity may carbonize (with normal temperature and current) and thereby lower resistance to reverse currents. Power losses then increase and hasten cell failure. Chemicals used in soldering or plating are sources of contamination. Most rectifiers now have welded housings, but where soldering is necessary (mostly internal) hydrogen-soldering is used. Painting is supplanting plating.

Selenium rectifiers have "end-of-life" built in at the factory. The increase in forward resistance with age and use determines throw-away time, and this can be predicted accurately. Conservative rating (with increased size and cost) makes this life as long as required. Input ac potential is often adjusted to compensate for aging; output dc potential can then be held constant throughout rectifier life.

Thermal runaway (regenerative heating to destruction) can be a problem, particularly with germanium. This metal has higher reverse-current and lower temperature limits than silicon, and poorer heat absorption than selenium. If combined (forward and reverse) generation of heat (a function of current and cell resistance) is more than the heat removed by cooling air (or liquid) in the temperature range involved, a chain reaction starts. The junction gets hotter, reverse heat generation increases rapidly, and so on until sudden failure occurs. The same applies to silicon, but at higher voltages and temperatures.

Upper frequency of ac source is limited by ability of the rectifier to purge itself quickly of electrons at end of forward conduction period. A junction acts somewhat like a capacitor, although the principle is different. High currents, similar to those in capacitor discharge, can result if potential is suddenly reversed. The smaller the active volume, the less time it takes to discharge; so large junctions have to operate at lower frequencies than small junctions. Large germanium and silicon cells

PERFORMANCE CHARACTERISTICS FOR FOUR RECTIFIER MATERIALS

For single cells, 60 cycle, single phase, operated at rated current and voltage with convection cooling in 35 C ambient.

	Copper oxide	Selenium	Germanium	Silicon
Avg. current density, dc amp/sq in.	0.1	0.25	200	2000
Peak reverse potential, volts	12	66	300	600
Forward potential drop, volts, at rated current				
new	0.5	1	0.3	0.8
aged	0.55	2	0.3	0.8
Max junction temperature, °C	80	150	100	200
Max frequency	low	low	high	high
Best rectification ratio, max forward current / reverse current	2,000	2,000	10,000	100,000
Efficiency at max volts, % power out / power in	85	95	99.5	99
Rate of breakdown at over-voltage condition	slow	slow	fast	very fast
Shelf life	Unlimited but may require reconditioning (forming).		Unlimited	

WHEN SELECTING A RECTIFIER

Direct comparison of 100-amp units using selenium, germanium and silicon, for 100-v dc output and 3-phase 60 cycle input, full-wave rectification, and forced-air cooling in 35 C ambient.

	Selenium	Germanium	Silicon
Volume, cu in.	4000	1100	400
Cost, $	50–400	180	93
Input potential, volts rms			
new	101	75	75
after aging	111	no change	no change
Individual cell efficiency, %			
new	82	98.8	98.2
after aging	72	no change	no change
Reverse current, milliamp (averaged for 1 cycle)	1000	100	10

can function in kilocycles, if the ac wave form is single-phase and smooth. Polyphase ac is more troublesome to rectify at high frequency because the cells must be switched (commutated) in ways that distort the voltage pattern and cause steep "wave fronts." This can create difficulty even at 60 cycles. An advantage of high frequency and polyphase is that smaller "filters" (capacitors, resistors, choke coils) are needed: This is because the energy per cycle is less. These closer-spaced, smaller energy changes result in a smoother pulsating dc.

LOOKING AHEAD

High-current germanium and silicon cells from 300 to 500 amp are beginning to appear. Single cells to handle well over 1000 amp can certainly be made—these larger cells may require some use of water or vapor cooling. Cell potentials in silicon have reached 500 v with several manufacturing methods. Where high potential is the main consideration, 1000 v can be achieved. Dc power supplies operating up to 100 kilocycles use germanium and silicon, and are competing with rectifier tubes. Silicon is ready to move to higher temperatures (above 250 C), and if operation beyond that point is desired silicon carbide can take over (up to 500 C).

Resistance to radiation is far better now. Also, the unusual sensitivity of many semiconductor materials to temperature, light, and magnetic fields has found application in control. Small size and good shock resistance make germanium and silicon useful in dc-excited ac generators—the rectifiers can be attached directly to rotor, eliminating slip rings. Several manufacturers are already working on commutator-less, rectified ac systems for automobiles, where economy, size, and low forward potential drop are very important.

REPRINT of this article can be obtained for your reference file by checking No. E24 on one of the Reader Service cards inside back cover. For other reprints available see "Current Reprints" listing in this issue on page 157.

EDITOR'S NOTE: Other aspects of semiconductors as rectifiers are covered in previous issues.

"Semiconductor Power Rectifiers," Mid-Oct '57, p 114, discusses cooling methods, overload protection, max ratings, and rectifier circuits for germanium cells; "Silicon Rectifiers Handle Kilowatts of Power," Oct '55, p 214, summarizes progress in silicon material.

Detailed performance, construction and circuit information on selenium rectifiers is presented in "Selenium Rectifiers for High-capacity Application," Mid-Oct '54, p 19. Tubes as rectifiers are part of a broad survey (with comprehensive tables) in "Electron Tubes for Industrial Applications," Mar '57, p 189.

Semiconductor diodes and transistors are described in "Transistors vs Tubes for Industrial Applications," Oct 28 '57, p 52. Their hopes for the future are thoroughly explored in "Semiconductors—Revolution at Hand," April 14 '58, p 60. A short preview of "Diamonds as Semiconductors" appeared Nov 4 '57, p 11.

LATIN SQUARES FOR FEWER TESTS— SAME ACCURACY

Why let variables force you to make 64 experiments when 16 will do? From an ancient puzzle-game comes this method that deserves wider popularity as a statistical shortcut to design.

DIMITRIS N. CHORAFAS
Catholic University of America

Variables mean trouble. For example, take four different designs for a dial. You want to evaluate them for readability, so you have four persons read each dial. That makes 16 tests. Then suppose each reading is to be made under four conditions of lighting. To get every possible combination you now need 64 individual measurements. And several sets of data may be required for representative results. Obviously, some method of reducing the number of measurements, without relying on mere guesswork, would save time and money.

Latin squares provide just such a method. They get their name from an ancient puzzle—how many ways can Latin letters be arranged in a square table so that each letter appears once and only once in each row and column?

As a design tool, setting up a Latin square is only one step in this variables-handling procedure. It is followed by two standard statistical techniques—one to compute variation in readability caused by experimental conditions, the other to decide which conditions should be considered important in final design. The Latin-square method can be applied to a wide variety of design problems.

SETTING UP THE SQUARE

To express the example in terms of a definite design problem, suppose the four dials represent proposed designs for aircraft altimeters: straight horizontal scale (H), straight vertical scale (V), round dial (R), semicircular dial (S). They are to be read by four pilots (W,X,Y,Z) under four lighting conditions: high (I), above average (A), below average (B), and low (L). By experiment we hope to find what effect dial design, lighting and pilot have upon accuracy of reading when the same reading time is allowed.

To program the experiment, draw a gridded square with a row for each condition of lighting, a column for each dial design, and letters for pilots assigned to cells in the square by one of several techniques.

LIGHTING	DIALS H	V	R	S
I	W	X	Y	Z
A	Z	W	X	Y
B	Y	Z	W	X
L	X	Y	Z	W

To prevent their reappearing in a row or column, letters are simply rotated one step as the rows are filled in from top to bottom. Another way would be to use a table of random numbers. There are 576 possible arrangements of letters for a 4 x 4 Latin square—161,280 for a 5 x 5 square.

A basic assumption with Latin squares is that experimental conditions are independent of each other. That is, dial design and astigmatism of operator may affect accuracy of the reading but it is assumed that they have no dependent effect on each other. This allows eliminating many combinations because row and column treatments balance—no letter appears twice in any row or column. Thus, 16 tests take the place of 64 without sacrifice of statistical reliability.

THE SQUARE GOES TO WORK

With the Latin square as a guide, a dial reading is taken for each combination of pilot, lighting and dial and the percent error is written in the appropriate space. Columns and rows are summed at bottom and side.

Readings are repeated several times to avoid stray errors. And to reduce "learning effect," altimeters are set differently for each reading.

		DIALS				
		H	V	R	S	Sum
LIGHTING	I	1.2	1.3	1.8	2.1	6.4
	A	0.9	1.1	2.0	1.6	5.6
	B	1.9	2.4	3.6	3.3	11.2
	L	3.6	3.2	5.4	4.6	16.8
	Sum	7.6	8.0	12.8	11.6	40.0

A glance at the table will reveal informative trends. For example, lighting seems to have the most effect on error. But how much effect does it have and what is the assurance that this is not simply a chance effect? In another example the trends might not be so clear-cut or the square might be so large that trends would be masked.

Statistical analysis, then, is the only way of coming to a final, reliable conclusion. The analysis has two parts: **computation of variance** and **analysis of variance.**

HOW MUCH SCATTER?

Variance is a statistical computation showing scatter about the mean—how individual values spread out from the average. The *mean* is the arithmetic mean.

$$\bar{X} = \frac{\Sigma x_i}{n}$$

where x_i is the value of each individual reading and n is the number of readings. But simply adding plus and minus variations from this mean will always give zero. Variance, then, is computed by squaring the variation from the mean for each reading, adding the values together, then dividing by number of readings less one.

$$s^2 = \frac{\Sigma (x_i - \bar{X})^2}{n - 1}$$

This is more commonly written

$$s^2 = \frac{\Sigma x_i^2 - \dfrac{(\Sigma x_i)^2}{n}}{n - 1}$$

because it does not involve actual computation of the arithmetic mean.

The denominator, $n - 1$, is called **degrees of freedom** (df). To illustrate the meaning of this statistical term assume a series of 10 variables (a, b, c, . . .) have a fixed mean value, 5. Any value can be chosen arbitrarily for 9 of the variables. But the 10th cannot be picked at random. There is only one value for the 10th that can cause the mean to be 5. Thus, there are 9 degrees of freedom—1 less than the number of variables.

For convenience, the numerator of the variation equation is computed first. The sum of the squared values of all 16 entries in the table is

$$(1.2)^2 + (0.9)^2 + (1.9)^2 \ldots + (4.6)^2 - \frac{(40)^2}{16} = 26.38$$

This is followed by summing for columns and rows, but now it is the sum of each column and row (not entries) that is squared, then divided by the number of readings it represents.

Dials (columns)

$$\frac{(7.6)^2}{4} + \frac{(8.0)^2}{4} + \frac{(12.8)^2}{4} + \frac{(11.6)^2}{4} - \frac{(40)^2}{16} = 4.9$$

Lighting (rows)

$$\frac{(6.4)^2}{4} + \frac{(5.6)^2}{4} + \frac{(11.2)^2}{4} + \frac{(16.8)^2}{4} - \frac{(40)^2}{16} = 19.0$$

And picking values out of the table for pilots

$$\frac{(10.5)^2}{4} + \frac{(10.2)^2}{4} + \frac{(8.5)^2}{4} + \frac{(10.8)^2}{4} - \frac{(40)^2}{16} = 1.12$$

Values for the column-and-row sum of squares are subtracted from total sum of squares to give residual sum of squares. This is the scatter that represents experimental error.

$$26.38 - 4.9 - 19.0 - 1.12 = 1.35$$

Each individual sum of squares has three degrees of freedom (four variables)—total sum of squares has 15 degrees of freedom (16 variables). Residual degrees of freedom is $15 - (3 + 3 + 3) = 6$. Standard statistical practice is to show values for sum of squares and degrees of freedom in tabular form for convenience in further computation.

	Sum of squares	df
Dials (columns)	4.90	3
Lighting (rows)	19.00	3
Pilots	1.12	3
Residual (error)	1.35	6
Total	26.38	15

These sums of squares measure how much each experimental condition causes variation from the mean reading error. They show, for example, that lighting causes the most variation—a sum-of-squares variation of 19. From this it might be concluded that changes in lighting have more effect on reading error than either of the other two experimental conditions. But what is the probability of this much variation occurring by chance?

SIGNIFICANCE OF VARIATION

Analysis of variance is, in part, an investigation of this chance effect. Before performing the experiment, a level of significance (α) was chosen. This value sets a limit for allowable variation about the mean. If, for example, a level of $\alpha = 0.05$ (commonly used in statistical experiments of this kind) is chosen it means that variations with less than a 5% possibility of occurring by chance will be accepted as meaningful variations. Thus, there is a 5% possibility of being wrong (simply a chance variation that is not meaningful at all) and a 95% possibility of being right.

Statistical tables are available that give values that can be compared with sum-of-squares values. Suppose

$\alpha = 0.05$ and we wish to find what variation is meaningful at a 0.05 level of significance. The ratio of lighting sum-of-squares to residual (or error) sum of squares, divided by corresponding degrees of freedom gives an *F ratio* of

$$\frac{19.00}{3} \times \frac{6}{1.35} = 28.13$$

The statistical tables give an *F ratio* of 8.94 for an α of 0.05 where there are 6 degrees of freedom in numerator and 3 in denominator. Thus any ratio of 8.94 has only a 5% possibility of occurring through chance and any ratio larger than 8.94 has less than a 5% possibility of being wrong because of chance. Lighting variation, then, is significant because a variation of 28.13 has less than a 0.05 probability of happening through chance. The other experimental conditions are examined the same way.

	Sum of squares	df	Mean Square	F Ratio	5% Ratio
Dials (columns)	4.90	3	1.63	7.25	8.94
Lighting (rows)	19.00	3	6.33	28.13	8.94
Subjects	1.12	3	0.374	1.66	8.94
Residual (error)	1.35	6	0.225		
Total	26.38	15			

Most statisticians agree that a level of $\alpha = 0.05$ is sufficient to judge experimental effects *significant* while a level of 0.01 is commonly referred to as *highly significant*. However, choosing a very low level ($\alpha = 0.001$) not only decreases the possibility of judging chance effects as significant, but also increases the possibility of neglecting a truly significant variation.

The last chart shows that lighting in this particular example is the only experimental effect causing a significant variation in reading error at the 5% level.

Hydraulic Extrusion

SOVIET STYLE

Experimenters report much less pressure needed for cold extrusion. Cushion of oil lubricates billets as it rams them through dies.

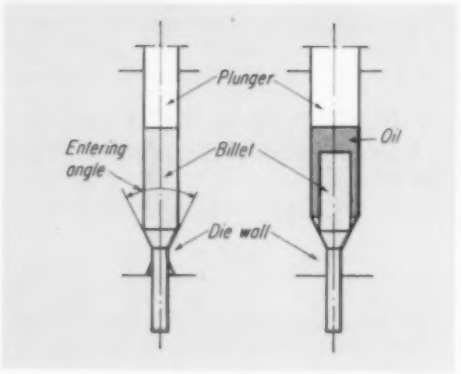
EUGENE GROS, *London, England*

Soviet engineers say they've found an easier way to extrude cold metals. It's done hydraulically. Pressure needed to force the metals through steel dies is much lower than with the usual plunger method, the Russians explain, because the hydraulic oil also acts as lubricant. By reducing friction, it allows extrusion of metals that have a yield point too high for the plunger method.

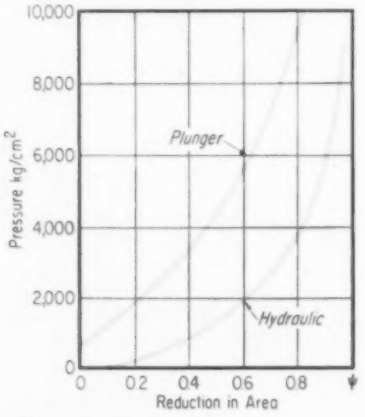
Two metals, aluminum and copper, are mentioned in the data published by B. I. Beresnev, L. F. Vereschagin and Y. N. Ryabinin covering experiments at Moscow's Laboratory of Superhigh-pressure Physics. No data is given for the work with copper. But the authors report hydraulically pressing aluminum billets through steel dies with only 42 atmospheres pressure. The dies were hardened to 62 Rockwell C, and had entering angles between 20 and 30°. These figures represent optimum results; the researchers experimented with other pressures and entering angles too.

They sum up benefits of their method: total pressure needed is less because of less friction in the die; pressure reduction leads to a lower friction coefficient between billet and die; lower coefficient leads to a considerable reduction of required entering angle; the oil also minimizes scoring in low-tolerance work.

The authors first published their work in *Ivestiya Akademii Nauk, Otdeleniye Tekhnicheskikh Nauk* (Bulletin of the Academy of Science, Technical Sciences Section).



Two ways . . .
to extrude cold metal. Billet at left is forced through die by conventional plunger method; at right, it's pushed by oil cushion.



Extruding aluminum . . .
gives these values for reduction in area vs pressure (kg/cm²); with plunger method and with hydraulic pressure. Entering angle of the die cone was 40°.

PACKAGED BELLOWS

. . . Hottest cost-saving idea in the controls field!

DON'T BE UNDERBID on equipment or systems involving metal bellows and accessories. Specify the completely assembled "package" from Bridgeport . . and save on handling, assembling, inspections, testing and paper work. Quantity purchasing and superior facilities assure you *absolute minimum* cost. Pass this saving on when you submit your bid.

Bellows metals to meet your tough conditions of temperature, pressure, vibration and corrosion . . . in sizes from $\frac{1}{4}$" O.D. to several inches O.D. Get the complete story on custom-engineered Bridgeport Packaged Bellows. Write for Bulletin A-105!

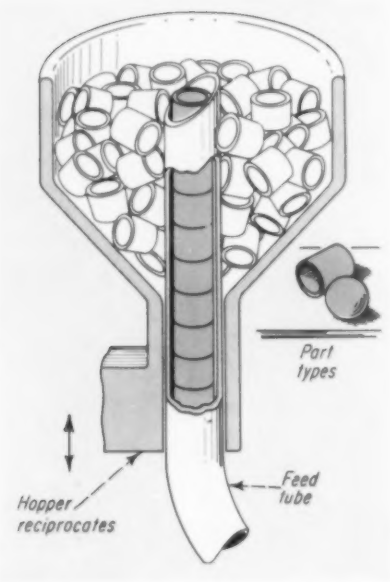
Mr. Controls

Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION
Milford, Connecticut

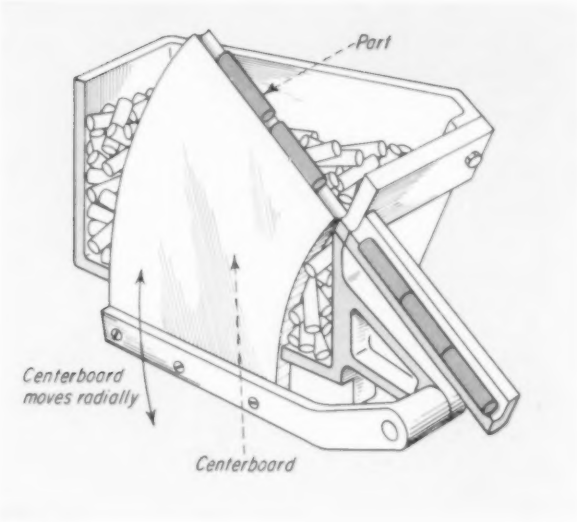
7 BASIC SELECTORS

Hoppers, feeding single parts to an assembly station, speed up many operations. Reviewed here are some devices that may not be familiar to all design engineers.



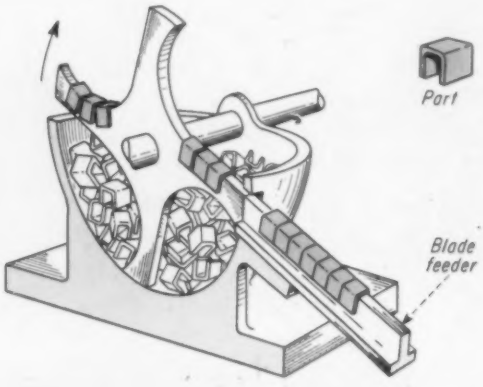
1

Reciprocating feed . . .
for spheres or short cylinders is perhaps the simplest feed mechanism. Either the hopper or the tube reciprocates. The hopper must be be kept topped-up with parts unless the tube can be adjusted to the parts level.



2

Centerboard selector . . .
is similar to reciprocating feed. The centerboard top can be milled to various section shapes to pick up moderately complex parts. It works best, however, with cylinders too long to be fed with the reciprocating hopper. Feed can be continuous or as required.



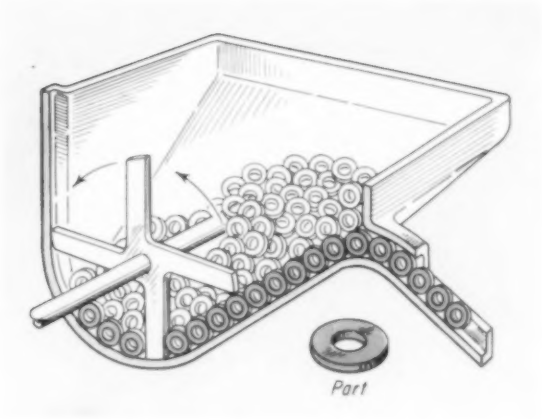
3

Rotary centerblades . . .
catch small U-shaped parts effectively if their legs are not too long. Parts must also be resilient enough to resist permanent set from displacement forces as blades cut through pile of parts. Feed is usually continuous.

○ for PARTS

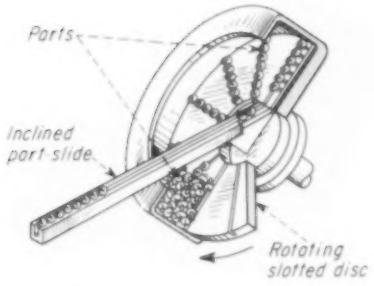
PETER C. NOY *Manufacturing Engineer*

Canadian General Electric Co., Ltd., Barrie, Ont.



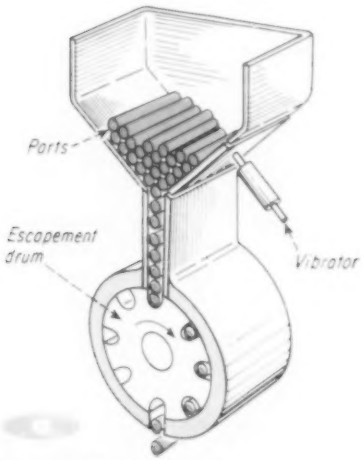
A

○ **Paddle wheel . . .**
is effective for disk-shaped parts if they are stable enough. Thin, weak parts would bend and jam. Such designs must be avoided if possible—especially if automatic assembly methods will be employed. *(PE—Mar. 31, '58, p 124.)*



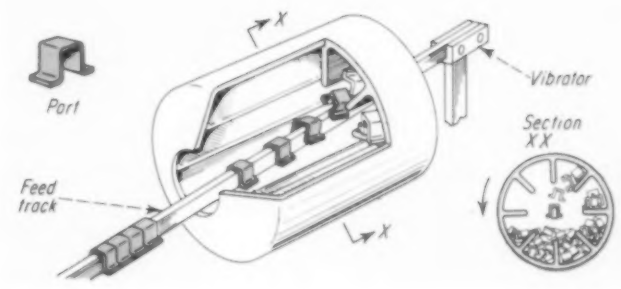
B

Rotary screw-feed . . .
handles screws, headed pins, shouldered shafts and similar parts. In most hopper feeds, random selection of chance-orientated parts necessitates further machinery if parts must be fed in only one specific position. Here, however, all screws are fed in the same orientation (except for slot position) without separate machinery.



C

Long-cylinder feeder . . .
is a variation of the first two hoppers. If the cylinders have similar ends, the part can be fed without pre-positioning, thus assisting automatic assembly *(PE—Mar. 31, '58, p. 124.)* A cylinder with differently shaped ends requires extra machinery to orientate the part before it can be assembled.



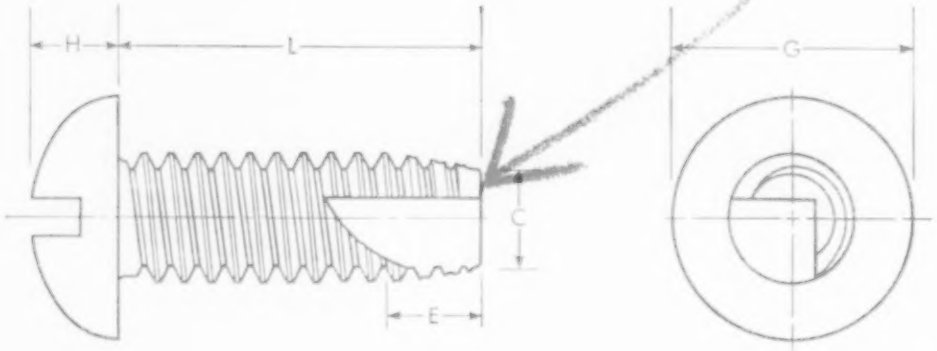
D

Barrel hopper . . .
is most useful if parts tend to tangle. The parts drop free of the rotating-barrel sides. By chance selection some of them fall onto the vibrating rack and are fed out of the barrel. Parts should be stiff enough to resist excessive bending because the tumbling action can subject parts to relatively severe loads. The tumbling sometimes helps to remove sharp burrs.

THREAD-CUTTING SCREWS

TYPE 23

ELIMINATES TAPPING—
CUTS COST 33%



GET TESTING SAMPLES FROM

FUNCTION: SHAKEPROOF Type 23 Thread-Cutting Screws cut perfectly mated threads in metal, die castings and plastics.

VARIATIONS: Type 1 Thread Cutting Screw has narrow slot and standard thread for certain hard metal applications; Type 25 for plastics has spaced thread and large cutting slot.

SPECIAL FEATURES: Pilot points, enamel-reaming points, double-end studs, headed shoulders. Thread-Cutting Screws can be pre-assembled with lock washers, fiber washers, flat washers, special stampings. Sealing compounds available.

HEAT TREATMENT: Special heat treating makes SHAKEPROOF Thread-Cutting Screws twice as strong as ordinary screws, often reduces the number or size of screws required.

REMARKS: Thread-Cutting screws reduce fastening cost as much as ⅓ by eliminating tapping operation. Ideal for use with automatic hopper-fed power screw drivers.

HEAD STYLES: All popular styles available including slotted, Phillips recess, hexagon and hexagon washer heads. Many special heads.

MATERIALS: Steel, stainless steel, aluminum, brass.

FINISHES: Cadmium plated, plain, parkerized or other finishes as specified.

DRAWN BY:		CHECKED BY:	
RDt	1/1/58	RMW	1/1/58

NOTE: Type 1 and Type 23 Thread-Cutting Screws cut a standard machine screw thread, can be removed and reused. Patented.

SHAKEPROOF
DIVISION OF ILLINOIS TOOL WORKS
St. Charles Road, Elgin, Illinois • Offices in Principal Cities
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

Take the guesswork out of . . .

CLEARANCE HOLE and DRILL SIZES

Two recent developments combine to overcome the old bugbear of tolerance build-up.

C. I. MILLARD, *Sandia Corp., Sandia, N. M.*

Recommended drill sizes for clearance holes are listed in the table on the continuing page. These holes are best located by the British Standards Institution method recently adopted by the ASA. This method eliminates errors caused when tolerances build up. Instead of locating a hole by a dimension to which an ordinary tolerance is applied, a tolerance is specified that represents a radius. Within this radius an individual hole center may vary from its true position in a datum plane. A clearance-hole dia will, therefore, be increased by twice the tolerance radius, or by a "tolerance diameter."

Data on hole oversize caused by drills of different sizes eliminates uncertainty concerning drill-size to hole-size relationship. The data were published by the Metal Cutting Tools Institute ("Drilled Holes for Tapping," 1954). The new method of tolerancing, and the drill data are combined in these tables.

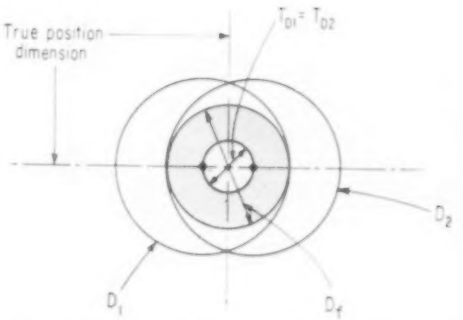
The equations in the diagrams can be used to solve for "tolerance-diameters" other than 0.014 in. and 0.028 in. (Note: The tolerance-diameter, in turn, has a tolerance applied to it.)

SYMBOLS:

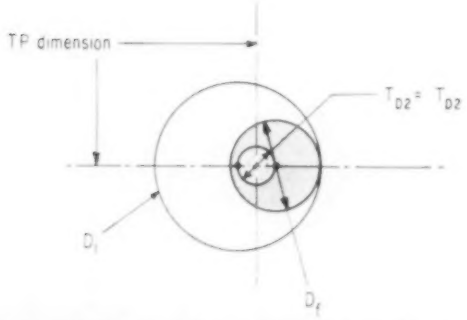
D_1, D_2 = clearance-hole min dia.
D_f = max fastener-dia.
T_{D1}, T_{D2} = tolerance dia ($= 2\ T_r$).
T_{r1}, T_{r2} = tolerance radii specified on a drawing.
Note: $T_{r1} = T_{r2}$ when the tolerance radii are equal.

Three basic arrangements . . .

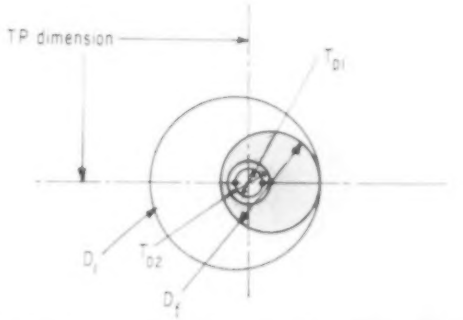
of holes. Correct clearance-hole dia is given by the equation for each arrangement. For most-used tolerances the clearance hole dia and drill sizes have been worked out in the tables on following page. Variations of hole produced by a standard drill are also given.



Identical clearance holes in both mating parts: $D_1 = D_f + T_{D1}$



Clearance hole in one plate, tapped hole in other plate: $D_1 = D_f + 2T_{D1}$



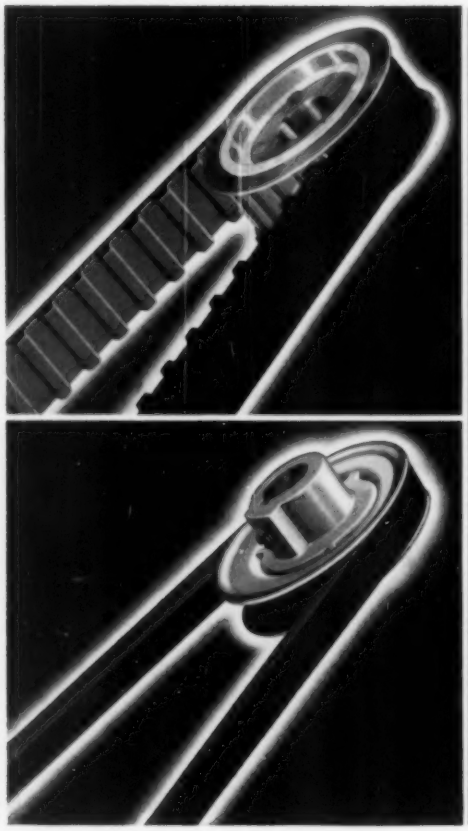
Clearance hole in one plate, tapped insert in other plate: $D_1 = T_{D1} + T_{D2} + D_f$

(Continued on page 101)

US RUBBER **PowerGrip** "TIMING" BELTS US RUBBER UNITENSION V-BELTS

The one RIGHT type of power transmission for your appliances:

U.S. POWERGRIP "TIMING" BELTS or U.S. UNITENSION V-BELTS



CONSIDER WHAT THE U.S. POWERGRIP "TIMING"® BELT CAN DO FOR YOUR PRODUCT:

It gives a simplicity of design with split-second machine response. Built specially for appliances, this belt has teeth which fit into the grooves in the pulley, giving it an efficiency of close to 100%. There is no slippage, no take-up. You can truly stream-line your appliance design—the absence of metal-to-metal contact eliminates need for lubrication and housing devices.

You get these extra advantages: • Smaller, lower-cost motor • Short and fixed centers, high ratio • Reduces assembly costs because fewer units are needed.

The housewife gains, too! • She gains a lightweight, foolproof appliance a woman finds easy to handle, and free of the need for maintenance and service calls.

You get a product easy to demonstrate, easy to sell.

HERE'S WHAT U.S. UNITENSION® V-BELTS WILL DO FOR YOUR PRODUCT:

They provide steady, dependable running on F.H.P. or multiple drives. The pulling members are electronically tensioned in perfect balance, *working as a team*—thereby increasing strength and decreasing vibration. This is the ideal belt for the mechanism that requires V-Belt power transmission.

A field force of "U. S." engineers will help you design the one *right* drive. Get to know the full meaning of the service they can give you. Reach them through your "U.S." power transmission distributor, or write us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

US RUBBER **Mechanical Goods Division**

United States Rubber

See things you never saw before. Visit U.S. Rubber's new Exhibit Hall, Rockefeller Center, N. Y.

CLEARANCE HOLE AND DRILL SIZE

Identical clearance holes in both mating parts.

Positional tolerance-dia,

$T_{D1} = T_{D2} = 0.014$ (±0.005), in.

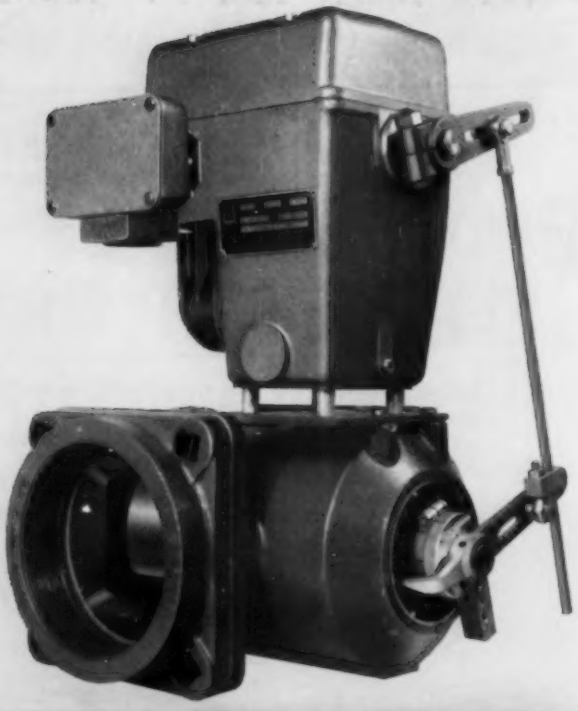
1. Identical clearance holes in both mating parts.
   Positional tolerance-dia
   $= T_{D1} = T_{D2} = 0.028$ (±0.010) in.
2. Clearance hole in plate 1.
   Tapped hole in plate 2.
   Positional tolerance-dia,
   $T_{D1} = T_{D2} = 0.028$ (±0.010) in.

1. Clearance hole in plate 1.
   Tapped hole in plate 2.
   Positional tolerance-dia,
   $T_{D1} = T_{D2} = 0.028$ (±0.010), in.
2. Clearance hole in plate 1.
   Insert in plate 2.
   Positional tolerance-dia
   (clearance hole) $T_{D1} = 0.014$;
   (insert) $T_{D1} = 0.012$, in.

Screw size	Max Screw Dia, D_f	Min dia clearance hole, D_1 or D_2	Drawing callout: Drill size	Drawing callout: Limits	Min dia clearance hole, D_1 or D_2	Drawing callout: Drill size	Drawing callout: Limits	Min dia clearance hole, D_1 or D_2	Drawing callout: Drill size	Drawing callout: Limits
2	0.0860	0.100	#39	0.100 0.104	0.114	#33	Δ*0.113 0.118	0.142	#28	¶*0.141 0.146
4	0.1120	0.126	1/8	*0.125 0.130	0.140	#28	Δ0.141 0.146	0.168	#19	¶*0.166 0.172
6	0.1380	0.152	#24	0.152 0.158	0.166	#19	0.166 0.172	0.194	#10	Δ0.194 0.200
8	0.1640	0.178	#16	*0.177 0.183	0.192	#11	*0.191 0.197	0.220	7/32	Δ*0.219 0.226
10	0.1900	0.204	13/64	*0.203 0.210	0.218	7/32	0.219 0.226	0.246	D	Δ0.246 0.253
1/4	0.2500	0.264	17/64	0.266 0.274	0.278	J	*0.227 0.284	0.306	5/16	0.313 0.321
5/16	0.3125	0.327	21/64	0.328 0.336	0.341	R	*0.339 0.347	0.369	U	*0.368 0.376
3/8	0.3750	0.389	25/64	0.391 0.399	0.403	Y	0.404 0.412	0.431	7/16	0.438 0.446
7/16	0.4375	0.452	29/64	0.453 0.461	0.466	15/32	0.469 0.477	0.494	1/2	0.500 0.509
1/2	0.5000	0.514	33/64	0.516 0.525	0.528	17/32	0.531 0.540	0.556	9/16	0.563 0.572
5/8	0.6250	0.639	41/64	0.641 0.650	0.653	21/32	0.656 0.665	0.681	11/16	0.688 0.697
3/4	0.7500	0.764	49/64	0.766 0.775	0.778	25/32	0.781 0.790	0.806	13/16	0.813 0.922
1	1.0000	1.014	1 1/64	1.016 1.026	1.028	1 1/32	1.031 1.041	1.056	1 1/16	1.063 1.073

* Functional because screw is usually undersize.
Δ Not suitable for fillister-head screws. Use pan head or washer.
¶ * Not suitable for any size head unless washers are used.

Power, ruggedness and accuracy for modern electric control systems ▸



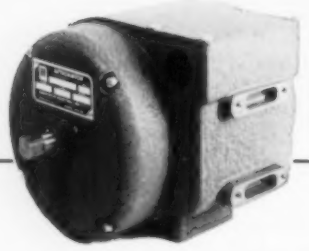
New INDUSTRIAL VALVE MOTOR SERIES 831E

Honeywell's new Industrial Valve Motor for valve or damper operation . . . for applications requiring maximum power and ruggedness . . . high accuracy and reproducibility of control.

This new, powerful motor is available for on-off, 2-position, floating or proportional control. Its features include:

- **EXCEPTIONALLY HIGH TORQUE**—up to 62.5 foot pounds.
- **FAST SPEEDS WHEN NEEDED**—from 3 to 120 seconds—full travel.
- **INTERNAL BRAKE**—provides exact positioning without coasting, holds load in any position when de-energized.
- **EASY ADJUSTMENTS**—internal limit and auxiliary switches easily accessible and adjustable in the field.
- **ARC SUPPRESSION**—circuit protects contacts of controllers and relays.
- **PROPORTIONAL CONTROL**—models have over-travel protection for the slidewire.

For complete details on the new Series 831E Industrial Motor, write for Specification S-804-2, or call your nearby Honeywell field engineer. MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.



ACTIONATOR* Series M630-M930

Gives dependable, low-cost service where the application calls for medium power.

Operate valves, dampers, louvers and other final control elements with this rugged, lightweight industrial motor. It's available with on-off, two-position, floating or proportional control. Its features include:

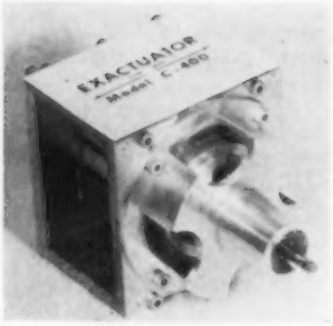
- **High torque ratings**—to 200 inch-pounds.
- **Fast speeds** available to meet application requirements.
- **Internal brake** to hold load in any position without coasting or hunting.
- **Easy adjustments**—readily accessible, field adjustable, cam-operated travel and auxiliary switches.

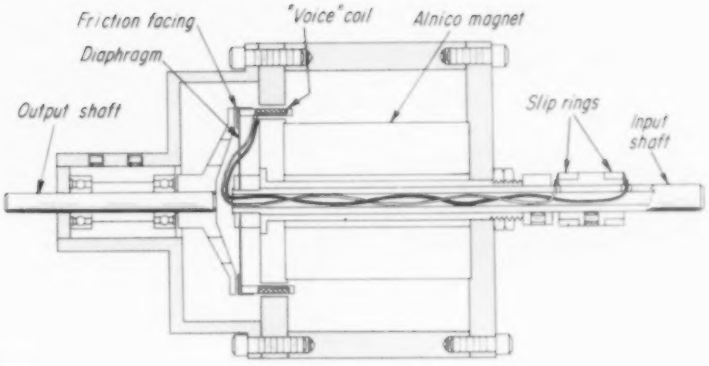
For details, write for Specification S-804-3, or call your nearby Honeywell field engineer.

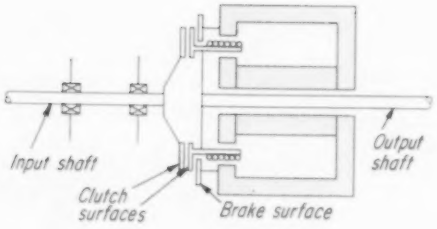
**Tradename Minneapolis-Honeywell Regulator Co.*

Honeywell

H HONEYWELL *First in Controls*







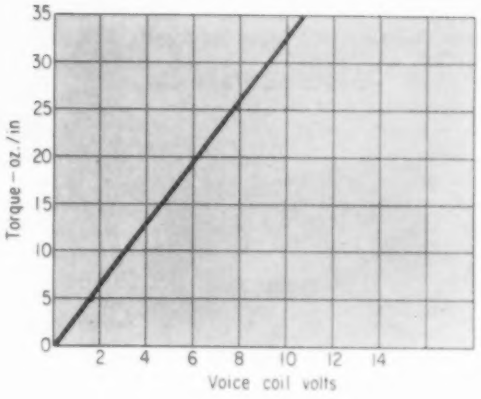
"Voice" Coil Actuates Clutch or Clutch-brake

A clutch designed for servo control systems, light-duty drives and instrumentation—and which is actuated by very low signals—is operated by moving coils, like those in a loudspeaker. The same basic design is used in clutch-brakes, by the same manufacturer. The coil can be made completely noninductive, if desired, and even in normal construction effective inductance is very low, because of the short-circuiting effects of the surrounding iron. The force exerted by a voice coil is linearly proportional to the current and not to the square of the current, as with electromagnets.

The force is constant for large excursions, thus eliminating adjustment for clutch wear. If the coil is either much shorter or much larger than the magnetic gap, the force remains constant for very large displacements. The force exerted is reversible with reversal of current, thus double-acting clutches or clutch-brake combinations are feasible with a single actuator. These coils are free of magnetic hysteresis and they store very little magnetic energy.

The clutch coil revolves in the magnetic gap. Since the magnetic field uniformly circular, this revolving of the coil has no axial effects. The model illustrated has a voice coil resistance of 1 ohm and a response time of better than 1 millisec. The torque is proportional to the current and the values for the illustrated clutch are shown in the graph. Coils of different resistance can be wound.

The iron structure is made of cold rolled steel with a central leg of Alnico V. The coil is supported by a flexible diaphragm which is perforated for the passage of air. The



output aluminum clutch plate is also perforated. In heavy-duty service, this clutch can be provided with a blower so that air can be fed past both sides of the coil, through the diaphragm, through the friction gap and through the output plate.

The over-all size of such clutches is generally somewhat larger than their electromagnetic equivalents; they produce

. . . CONTINUED ON PAGE 104

less torque for same size. Size can be reduced by using cylindrical magnetic structures at some slight sacrifice in magnetic efficiency. Minimum size is about ½ in. over-all.

While the clutch shown uses slip rings, such clutches can be designed with fixed voice coils with the force transmitted through a rotary joint to a separate friction mechanism. No slip rings are necessary when the device is used as a brake.

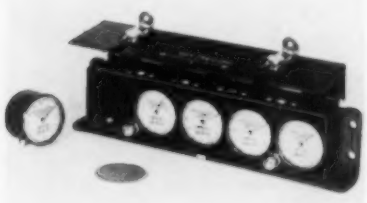
Prices on the clutch and clutch-brake units not available; delivery, about 2 mo. **Norman Hardy Assoc., 414 Gribbel Road, Wyncote, Penna.**

Circle 1, inside back cover

Dual-purpose seal . . .

is used primarily as a spring. It has a controlled spring load of 20 lb (±2) at 0.040-in. deflection. Operating at 1000 F, these characteristics permit it to replace many parts and it can be used for a bearing load rotary face seal loading device and as a controlled spring. Under controlled, environmental tests, seals have withstood tests of up to 75 million compression cycles without failure due to fatigue. Seal is 5 in. OD for high-temperature applications. It can be provided in sizes from ½ to 33 in. OD for most existing temperature and pressure requirements. **Skinner Seal Co., 3001 Sutter St., Santa Ana, Calif.**

Circle 2, inside back cover



Recorder counts jolts . . .

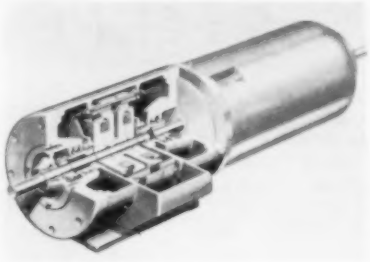
and ignores jars. The 2-oz accelerometer contains a self-energized seismic movement that can be set to respond only to accelerations exceeding a chosen value within its range, which normally is from 2 to 12 g. It has a max counting rate of 15 counts per sec. Natural frequency is 25 cps and operation is clamped at 0.7 of critical. Axis of accelerometer movement is parallel to 12 o'clock pointer position and operation is controlled by a button. Up to 3600 counts may be recorded by two-pointer display. May be mounted in remote parts. A typical five-instrument mounting is illustrated with one accelerometer removed to show mounting details. May be used for determination of shocks and jolts during shipping of merchandise or installation of equipment or analysis service conditions during operation or test. **Research, Inc., 115 N. Buchanan St., Hopkins, Minn.**

Circle 3, inside back cover

Urethane rubber . . .

can be cast at atmospheric pressure into industrial parts where high load-bearing and long-wearing properties are critical requirements. Can be bonded to metal and used with or bonded to rigid inserts for service in gears, wheels, rollers and platens. Available in standard formulations covering a range of hardness from 62 to 95 Shore A, having tensile strengths of 4200 to 7300 psi and having ultimate elongation values of over 500%. Material is also said to have abrasion and tear resistance, good rebound elasticity, and resistance to ozone, solvents, sunlight aging and oxidation. **Acushnet Process Co., New Bedford, Mass.**

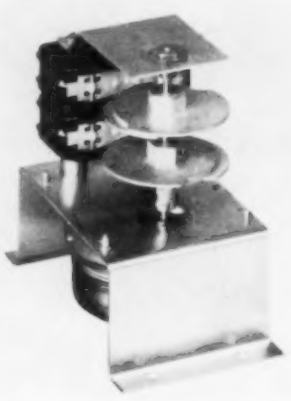
Circle 4, inside back cover



Variable-speed drive . . .

is infinitely variable, using constant-speed motors. Because there is no mechanical connection between prime mover and load, unit is shockproof. Load can be engaged or disengaged electromagnetically without stopping prime mover. Four drip-proof models in six sizes will handle motors up to 150 hp at 1750 rpm. Max torque transmittal is 450 ft-lb. Peak torque capacity is from 200 to 250% of rated torque. Heat dissipation is achieved through a bimetal casting that also functions as a fan that circulates cooling air through the drive. Driven by motors up to 100 hp at 1750 rpm, will operate stalled at full torque without overheating. Speed can remain constant with varying torque, or speed can vary inversely with torque, or there can be a combination of these. May be wired for remote or automatic control. Applicable as drives for fans, pumps, compressors, extrusion machines, and machines requiring rapid and frequent reversal. **Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12.**

Circle 5, inside back cover



Recycling timers and kits . . .

in single, double and three-gang assemblies are said to be low-cost units for testing, flashing, process control and lab applications. Speeds varying from 50 cpm to 1 rev/hr are available. Units have 115-v, 60-cps synchronous motors and SPDT 15-amp at 125-v ac switches. 75 standard types are available from stock. **Herbach & Rademan, Inc., Dept. PR-E-1, 1204 Arch St., Philadelphia 7.**

Circle 6, inside back cover

Digital voltmeter . . .

is transistor-equipped and also operates as an analog to digital converter capable of 2000 completely independent conversions per sec. As a digital voltmeter, the machine allows following of changing voltages without confusing display. After the unit has made one conversion, it is ready to make another whenever actuated by an external trigger. As an analog to digital converter, the unit can be incorporated into most systems because of the variety of outputs available: visual output in large illuminated numbers; decimal output for

. . . CONTINUED ON PAGE 106

BRIDGEPORT BRASS
COPPER ALLOY BULLETIN

Bridgeport Reporting New Developments in Copper-Brass Alloys and Metalworking Methods

Cored Forgings for Better, More Intricate Parts at Lower Costs

Compared with casting or solid forging, Bridgeport cored forgings save up to 50% in materials . . . cut machining and finishing time...reduce tool costs...eliminate rejects.

Cored forgings can be held to fine tolerances with accuracies of 0.005". They have great strength, high density, uniform grain structure, no porosity, and an extremely fine-textured hardware finish. High strength parts can be forged closer to finished forms than by other methods.

Send a sample part or assembly, together with full specifications, to the National Cored Forgings Division of Bridgeport Brass. Cost estimates will be supplied.

Typical cored-forged parts

Metal Laminates Solve Design, Production Problems

Bridgeport Metal Laminates provide combinations of chemical, physical and mechanical properties unobtainable in a single metal. Use them to solve dual corrosion problems, improve electrical and thermal conductivity, combine high thermal conductivity with corrosion resistance, and provide greater strength-to-weight ratios.

Write for test samples and for a copy of the 8-page booklet detailing applications, properties, types, sizes, etc., of Bridgeport Metal Laminates.

Stock Temper Bridgeport Wire Meets Many Special Cold Heading Needs

A few of the wide range of Rockford Screw Products fasteners made with Bridgeport wire.

Bridgeport's high-quality standard alloys help produce superior products and cut costs too. For example, Rockford Screw Products, Rockford, Ill., finds it possible to use our *stock temper* wire for a wide range of special and standard fasteners. Gains in economy are obvious. To conserve material and reduce manufacturing costs, the company cold heads the parts. Bridgeport Brass and Copper Alloy wires have the high qualities of malleability, ductility, strength and stiffness for this process.

Alloys Used

Three Bridgeport Alloys are used by Rockford Screw Products:

70-30 Brass 69: an extremely ductile wire, particularly suitable for making exceptionally large heads and certain types of hollow rivets.

Silicon Bronze 609: an outstandingly malleable alloy even in hard-drawn condition. Finished bolts above 100,000 lb per square inch can be produced from it. This alloy is highly resistant to stress-corrosion cracking and is suitable for outdoor construction where brass and steel may not be satisfactory.

Commercial Bronze 25: although named "commercial bronze," this alloy does not contain tin. It resists season-cracking and is more resistant to dezincification than brass. It is recommended for interior or exterior applications.

Bridgeport's Wide Range of Alloys

Rockford Screw Products has found that corrosion resistance, lasting strength and hardness, and ease of finishing make Bridgeport Brass and Copper Alloys ideal for all types of industrial fasteners. And the great variety of alloys available assures the selection of a metal with exactly the right characteristics for any particular job.

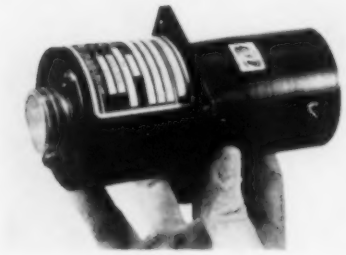
Whatever the application and whatever the industry, Bridgeport Alloys help improve products, smooth production, cut costs. Your Bridgeport Salesman will be happy to advise you—and through him is available the full experience and facilities of Bridgeport's Technical Service. Call him.

BRIDGEPORT BRASS

Bridgeport Brass Company, Bridgeport 2, Conn. • Sales Offices in Principal Cities
In Canada: Noranda Copper and Brass Limited, Montreal

driving units directly; binary-coded decimal output that provides code and full complement simultaneously; an output register containing five binary bits for each decimal digit. Printed circuit cards can be inserted only in the correct location in the unit. Mounts on a standard RETMA relay rack and occupies 5¼ in. panel space. Operates on 105 to 125-v ac input, 45 to 1000 cps, approximately 20 w. Accuracy is ±0.05% of full-scale voltage range plus ½ the least significant digit. **Adage, Inc., 292 Main St., Cambridge 42, Mass.**

Circle 7, inside back cover



Timer limits contact bounce . . .

to within a range of 50 to 300 microsec. Up to five independent channels are available in standard interval timer and events may be sequenced simultaneously or in a series, or in a combination of both. Switches operations at precise time intervals for electrical circuits ranging from 1 sec to several hours. Consists of a synchronous motor, a cam and positive action contact arrangement in which one set of contacts makes the circuit and another set breaks it. Contacts are designed for a load current of at least 0.5 amp and are capable of operating satisfactorily with higher currents. Timer is supplied to operate at various input voltages on 60 and 40 cps ac or dc. Units are 5 in. long; have a 2.2 in. dia and weigh 1.5 lb. **Western Design & Mfg. Corp., Santa Barbara Airport, Goleta, Calif.**

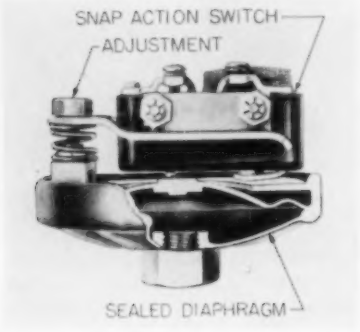
Circle 8, inside back cover

Bonded rubber rod ends . . .

absorb shock and impact loads, isolate vibration, need no lubrication and are said to overcome service life limitations introduced by radial play and metal-to-metal contact present in spherical ball joint designs. Rod ends consist of an inner member or spacer, an alloy steel eyebolt and a bonded flexing element which is specially compounded. Furnished with threads for externally or internally threaded rods. Accommodate misalignment and dimensional deviations permitting larger tolerances in attaching parts. Torsional deflections to

±30° and angular deflections to ±7° are normally provided with variations of ±50% in spring rate. Available in a large size range. Rod ends weighing less than 1 oz are rated for loads of 15 lb. **Lord Mfg. Co., 1635 W. 12th St., Erie, Penn.**

Circle 9, inside back cover



Pressure and vacuum switches . . .

in stripped models are for installation where controls are enclosed in a common cabinet. Operates in any position, obviating balancing or levelling. Can be mounted directly on moving or vibrating equipment. Recommended for liquid, gas or water systems, the series is available in proof pressures of 30 in. Hg to 150-psi pressure. It senses any system pressure over an adjustable range of 30 in. Hg to 100 psi pressure and actuates an electric circuit at predetermined pressure, increasing or decreasing. UL-listed SPDT switching elements for ac and dc circuits are automatically reset by the snap-action of the switches. **Barksdale Valves, Pressure Switch Div., 5125 Alcoa Ave., Los Angeles.**

Circle 10, inside back cover

Numerical control package . . .

is a two-motion unit that can be applied to any machine requiring point-to-point positioning of linear or rotary motions. Motors, operator's control, position pickup devices and tape reader are included. Unit cannot be modified, but provisions have been made for control of auxiliary functions from punched tape by addition of necessary electrical devices. Control offers positioning speeds to 60 in. per min. Provides for individual or simultaneous linear and rotary positioning, and has an electrical accuracy of 0.0005 in. at travel lengths up to 99.99 in.; of 0.005 in. at travel to 399.99 in. Operates from numerical data stored in standard 8-channel, 1-in.-wide punched tape and/or manually set decade switches, and is capable of semi-automatic and automatic operation. Servo drives, up to ¾ hp max, are controlled by a special, adjustable speed drive. For applications requiring servo drives greater than ¾ hp, basic unit can be used with amplidynes and larger motors. Standard design is under $10,000 net for resale and is available for off-the-shelf delivery. **General Electric Co., Schenectady 5.**

Circle 11, inside back cover

Air poppet valve . . .

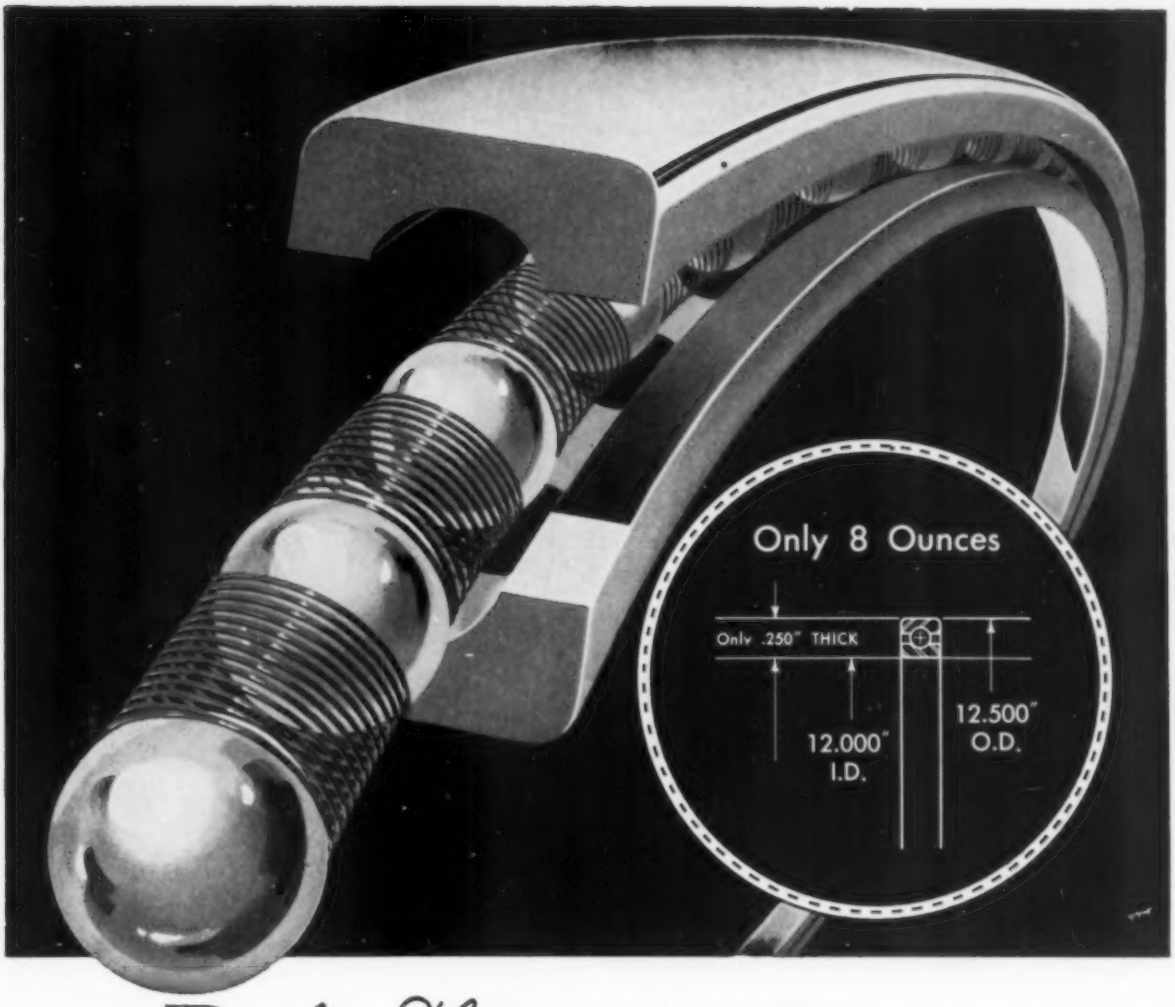
is primarily for use as an energizing medium for pilot-operated air control valves. May be actuated by hand or by some mechanical means, direct or remote. Valve releases a measured amount of air from pilot chamber of air control valve upsetting a static pressure balance and causing a movement of valve spool. This, in turn, changes directional flow through control valve. Opens and closes only when plunger is compressed. It is, therefore, unnecessary to decompress plunger before control valve is energized in the opposite direction. Suited to air-operated automatic machine tool equipment and other air-controlled industrial applications. **Savage Engineering Div., Lithibar Co., 345 W. 14 St., Holland, Mich.**

Circle 12, inside back cover

Dual-spool air valve . . .

is controlled by a solenoid, which activates an inner spool, which in turn releases compressed air to energize outer spool. Current requirements are 0.8-amp inrush and 0.125-amp holding at 115 v, 60 cps. A clamp ring permits removal of solenoid cover and assembly. Valve can be converted from a single solenoid to a double

. . . CONTINUED ON PAGE 108



Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No. 54RS-2.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 5/16" and in bore diameters from 5" to 40".

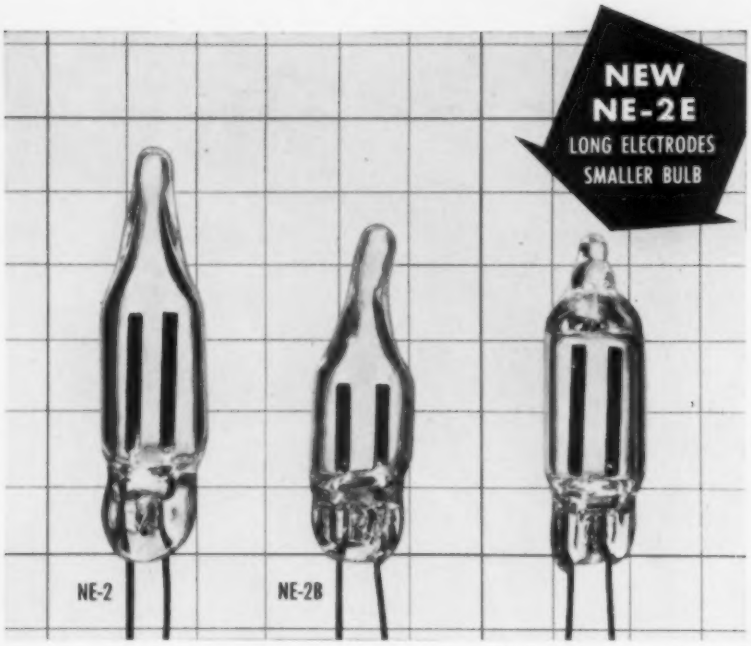
K-554

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" bore to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings



Three diameter enlargement

Introducing General Electric's NE-2E Glow Lamp

NEW "SNUB-NOSE" DESIGN PERMITS LONG ELECTRODES IN SMALLER BULBS FOR BETTER PERFORMANCE

The new General Electric NE-2E is as small in length as the NE-2B—yet has electrodes fully as long as those in the larger NE-2. The exclusive molded tip permits use where space is restricted—performs better and provides better indicator viewing—especially end-on.

Only glow lamps offer small size, low wattage, long life, wide voltage tolerances, rugged construction. And they don't fail suddenly—so there's almost no chance of false indications.

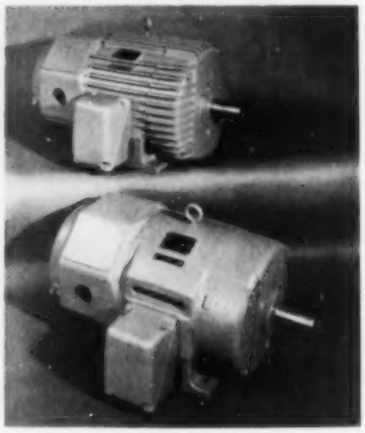
Any G-E Glow Lamp can be used in many ways. A single lamp may serve as a relaxation oscillator, a leakage indicator, a switch, a voltage regulator, or a voltage indicator. Send for the folder, "G-E Glow Lamps As Circuit Control Components". Write: General Electric Co., Miniature Lamp Dept. PE-58, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

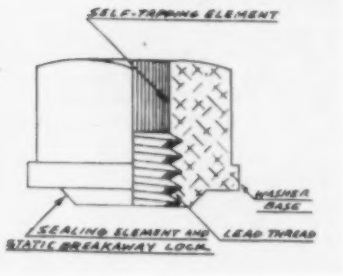
by removing retainer head and inserting a covered solenoid assembly. Circular-flow design is reported to minimize right-angle turns and provide full air flow throughout rated capacities. Available in ¼ in. through 1¼-in. port sizes. To convert valves of one size to another, only base need be changed. **Mechanical Air Controls, Inc., 10030 Capital, Oak Park, Detroit 36.**

Circle 13, inside back cover



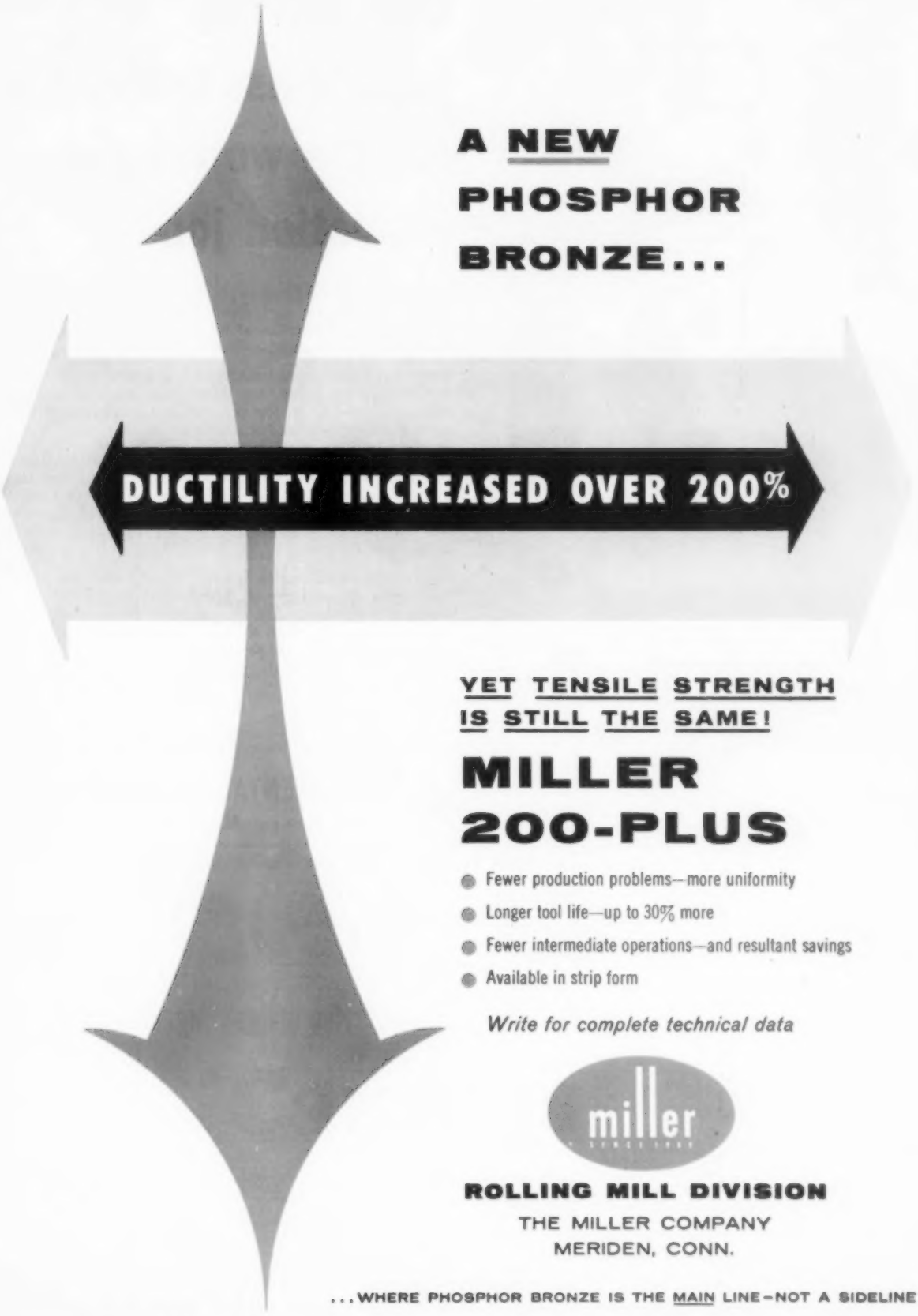
Two wound rotor motors . . . are said to be as much as 59% smaller and weigh 49% less than previous models. Available from 5 through 150 hp. One series of motors is rated for intermittent duty, such as crane and hoist operation, and is available in either totally enclosed nonventilated or drip-proof enclosures. Best suited to applications requiring varying speed and high starting or max torque. A second series, rated for constant or adjustable speed, is available in open drip-proof enclosures for application on industrial equipment such as pumps, compressors and fans. Class B insulation is used. **General Electric Co., Schenectady 5.**

Circle 14, inside back cover



Self-tapping stop nuts . . . lock, seal and insulate. Nuts lock at any position along screw shank. As the screw turns into the nylon, a counter-compressive force is built up, resulting in a tight

(Continued on page 112)



A NEW PHOSPHOR BRONZE...

DUCTILITY INCREASED OVER 200%

YET TENSILE STRENGTH IS STILL THE SAME!

MILLER 200-PLUS

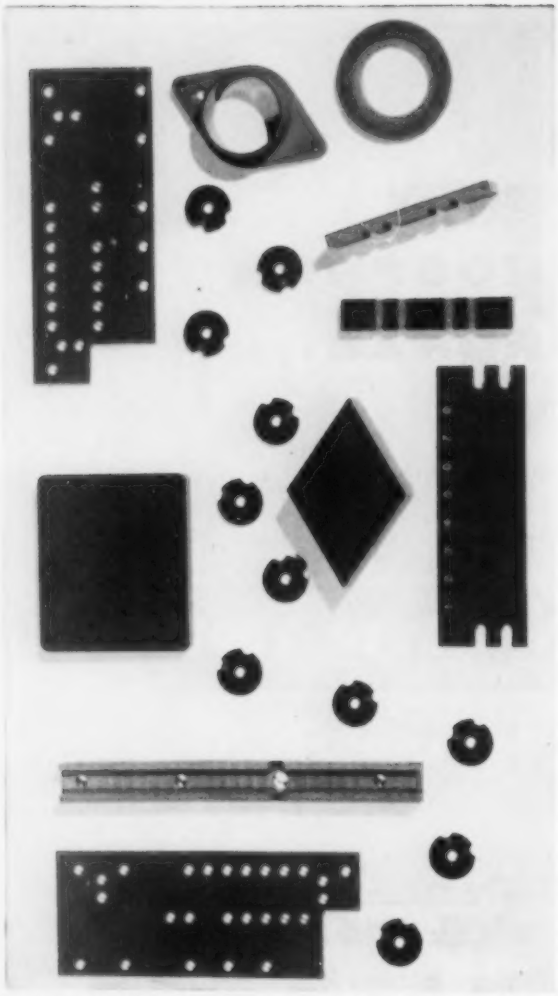
- Fewer production problems—more uniformity
- Longer tool life—up to 30% more
- Fewer intermediate operations—and resultant savings
- Available in strip form

Write for complete technical data

miller

ROLLING MILL DIVISION
THE MILLER COMPANY
MERIDEN, CONN.

...WHERE PHOSPHOR BRONZE IS THE MAIN LINE—NOT A SIDELINE



Fabricated by CDF. Near the presses that produced the Dilecto laminates, these paper-base parts were machined to close tolerances by CDF specialists . . . quickly, accurately, economically for the purchasers. This is a random selection from the five grades described in the table below.

CDF Dilecto® paper-base laminates for the workhorse insulation jobs

For everyday mechanical-electrical parts that receive tough punishment and must have excellent physical and dielectric properties at low cost, the CDF phenolic paper-base line is outstanding.

Economy. CDF paper-base grades machine readily into intricate parts. Some are flame-retardant. Others are especially adaptable for punching. All are economical for the value delivered.

Fabrication Facilities. CDF has excellent and extensive plastics-fabrication facilities for turning out finished Dilecto parts to your specifications—better and more economically than you can do it yourself. Save the time and trouble of intricate fabrication by using CDF's specialized facilities.

See Sweet's, Electronics Buyers' Guide, and the other directories for the phone number of the CDF sales engineer nearest you. Or send us your print or problem direct, and we'll return a recommendation of the right Dilecto grade for your need.

CDF makes Di-Clad* printed-circuit laminates, Diamond* Vulcanized Fibre, CDF products of Teflon†, flexible insulating tapes, Dilecto* laminated plastics, Celoron* molded products, Micabond* mica products, Spiral Tubing, Vulcoid*.

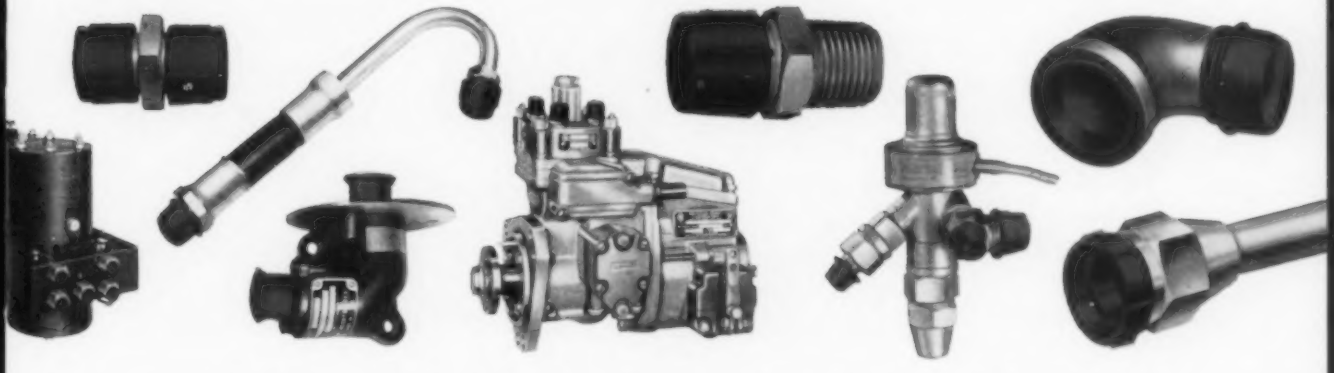
*Trademark of Continental-Diamond Fibre Corporation
†Du Pont trademark for its TFE-fluorocarbon resin

CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE Budd COMPANY • NEWARK 40, DEL.

Typical Property Values—Dilecto Paper-Base Laminates in Sheet Form

	X-13 (NEMA X)	XP-13 (NEMA P)	XX-13 (NEMA XX)	XX-13 FR (Fire-retardant) (NEMA XX)	XXXP-28 (NEMA XXXP)
ROCKWELL HARDNESS	100	95	110	108	90
TENSILE STRENGTH lw (1000 psi.)	20	12	16	17	12
FLEXURAL STRENGTH lw (1000 psi.)	27	16	17	20	18
COMPRESSIVE STRENGTH (1000 psi.)	40	25	35	41	22
WATER ABSORPTION (% in 24 hrs.) 1/16" thickness	3.5	3.0	1.4	1.2	0.6
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (°C.)	120	120	120	120	120
DIELECTRIC STRENGTH perp. to lam. (VPM)	800	800	650	700	800
DIELECTRIC STRENGTH parallel to lam. (Kv.)	50	50	60	70	75
DISSIPATION FACTOR at 1 mc, Cond. A	0.042	0.038	0.034	0.038	0.027
DIELECTRIC CONSTANT at 1 mc, Cond. A	5.5	4.6	4.7	4.8	3.6
ARC-RESISTANCE (seconds)	8	4	4	10	10
INSULATION RESISTANCE (megohms) ASTM D-257, Fig. 3	100	100	1,000	1,000	600,000
AIEE insulation class	A	A	A	A	A

Caplugs protect nearly everything under the sun...in process, storage and transit...



prevent damage to threads and delicate parts...keep out dirt and moisture...

made of tough, flexible polyethylene...won't chip, break, shred or collapse

Caplugs

10 standardized styles... over 500 sizes in stock

get a free handful
of Caplugs in exchange
for the attached coupon

CAPLUGS DIVISION, Protective Closures Co., Inc.
2205-9 Elmwood Avenue, Buffalo 23, N. Y.

MAIL a free assortment of Caplugs, literature and prices to us, without obligation.

NAME _____

TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

ACME

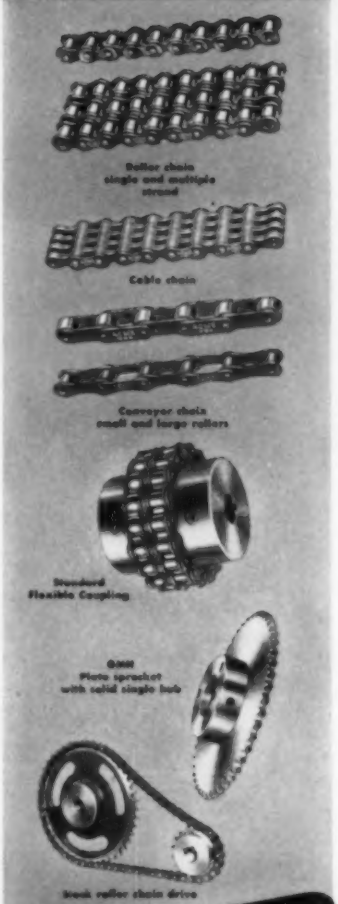
GETS THE CHAIN TO YOU WHEN YOU NEED IT

No costly delays when you specify ACME

With Acme you can be sure there won't be any costly delays or production line shut-downs because of non-availability of replacement parts. We back our Industrial Distributors with complete stocks of all standard Roller Chains, Double Pitch Chains and Sprockets ready for immediate shipment in case of emergency.

On Time Delivery is but one of many Acme Services that assures customers of maximum production efficiency and economy. Call on us at any time for Engineering Service and advice.

prompt delivery in all sizes on ACME chains, sprockets, couplings in any quantity from your Distributor


Roller chain single and multiple strand
Cable chain
Conveyor chain small and large rollers
Standard Flexible Coupling
QMM Plate sprocket with solid single hub
Inset roller chain drive

Write Dept. 1-V for new illustrated 100 page catalog which includes new engineering section showing 36 methods of chain driving.

Call **ACME** for Service

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

friction lock. Further tightening causes the cone at base of nut to extrude into clearance spaces, forming a seal against liquid or gas escape, or entrance of corrosive influences. Nylon hexagonal nuts are available in standard sizes Nos. 4, 6, 8, 10, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$ and $\frac{1}{2}$ in. **Byrd Plastics, Inc., 2953 W. 12th St., Erie, Penna.**

Circle 15, inside back cover

Metal-filled epoxy resins . . .

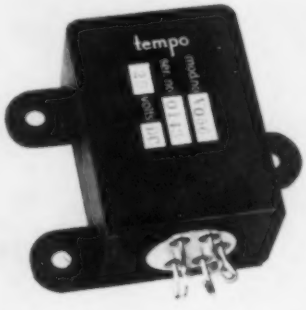
are two-component, room-temperature-curing materials for making strong castings with properties likened to those of metal castings, for making molds for short-run use, and for filling voids and plugging holes in all-metal structures, wood, plastics. Especially designed for filling honeycomb structures for insertion of bolts and hangers. Pull-out strength is reported greater than honeycomb strength. Tensile strength is 8000 psi; compressive strength, 12,500 psi. Temperature limits are 0 to 225 F. Shelf life is about 1 yr. **American Latex Products Corp., 3341 W. El Segundo Blvd., Hawthorne, Calif.**

Circle 16, inside back cover

Hermetically sealed switch . . .

is rated 1650 v dc and 20 milliamp. SPDT switch operates on 28 v dc. At rated voltage, coil current is 2.3 amp. Service life expectancy is about 50,000 makes and breaks and switching time is about 90 millisec. Switch has been engineered to meet applicable military environmental tests for shock, vibration, humidity, corrosion and temperature range. The remotely controlled rotary switch is $3\frac{33}{64}$ x $2\frac{7}{16}$ x $1\frac{53}{64}$ in. wide max. Weight is 14 oz. **G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio.**

Circle 17, inside back cover



Subminiature delay relays . . .

are all-electronic, utilizing transistors and time-constant circuit elements. All moving parts except relay contacts have been eliminated. Time delay periods from 0.01

(Continued on page 116)

Kodagraph Autopositive Paper strengthens line detail, drops out stains—turns old drawings into new ones.

Saved: $195 in Redrafting costs by making a Kodagraph Autopositive Paper intermediate

BEFORE you retrace another soiled or weak line drawing ask your print room or local blueprinter to figure the cost of making a Kodagraph Autopositive Paper intermediate.

The saving in dollars, even with the smallest drawing, is reason enough to end the retracing chore for good. The line detail on an Autopositive intermediate, unlike a pencil drawing's, won't smudge or smear when it's pulled from the files . . . will remain legible even after being used hundreds of times for reference or printmaking.

The smartest move, of course, is to make an Autopositive Paper intermediate of every drawing in your active files. Use these for all reference work and printmaking. This way you'll protect your valuable originals, and get top-quality prints time after time.

FREE: Write today for your copy of "New techniques . . . new savings with Kodagraph Reproduction Materials." Jam-packed with valuable tips on saving drafting time, protecting drawings, getting better prints.

EASTMAN KODAK COMPANY
Graphic Reproduction Division, Rochester 4, N.Y.

Kodagraph
Reproduction Materials

• • • • • • • • • MAIL COUPON FOR FREE BOOKLET • • • • • • • • •

EASTMAN KODAK COMPANY
Graphic Reproduction Division,
Rochester 4, N.Y.
Gentlemen: Send me a free copy of your booklet on Kodagraph Reproduction Materials.

15-5

Name _____

Position _____

Company _____

Street _____

City _____ Zone _____

State _____

Kodak
TRADEMARK

KOHLER ENGINES

4-CYCLE SHORT-STROKE AIR-COOLED

MODEL
K90

- Balanced crankshaft—ball bearings at both ends
- Externally mounted breaker points
- Positive splash lubrication
- Aluminum alloy cylinder head—deep fins for efficient cooling
- Mechanical governor for accurate RPM control

Riding Tractors
Rotary Tillers • Orchard Sprayers
Centrifugal Pumps • Weed Cutters
Highway Line Markers • Conveyors
Riding Lawn Mowers • Turf Aerators
Snow Blowers • Refrigerated Trucks

IN Action-Everywhere

Lawn Rollers • Cultivators • Grain Blowers • Milkers • Grain Elevators
Disc Grinders • Pump Jacks • Portable Saws • Sprayers • Motor Bikes
Hoists • Floor Sweepers • Augers • Air Compressors
Concrete Mixers • Vibrators • Scooters • Rail Drills
Sand Spreaders • Spike Pullers • Tie Tampers
Kohler Electric Plants

FROM 3 TO 24 H.P.

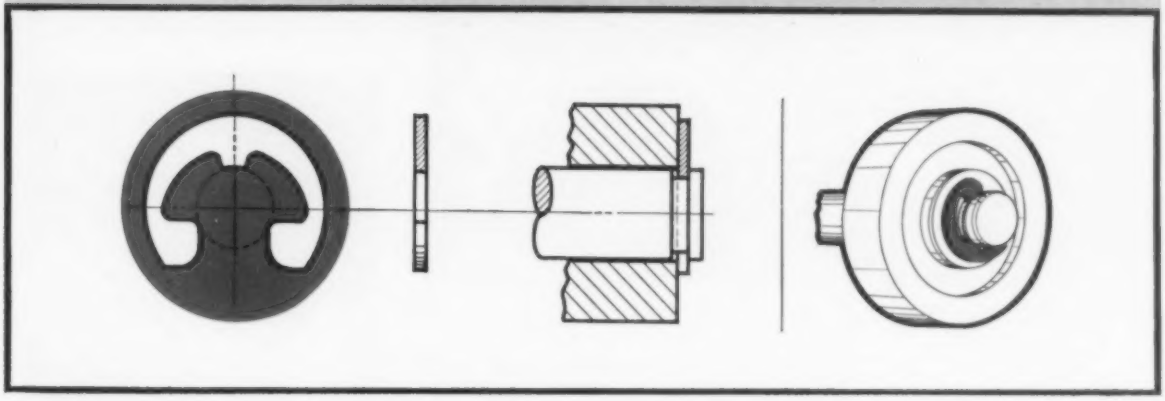
Send for 28-page illustrated booklet

KOHLER CO. Established 1873 KOHLER, WIS.

KOHLER OF KOHLER

Enameled Iron and Vitreous China Plumbing Fixtures • Brass Fittings • Electric Plants • Air-cooled Engines • Precision Controls

New Waldes Truarc Reinforced "E-ring" Provides 5 Times More Gripping Power, 50% Higher RPM Limits Than Conventional E-Type Rings



The new Waldes Truarc Series 5144 is a radially-installed reinforced "E-ring." It is designed for use in assemblies where the ring is subject to strong push-out forces resulting from heavy vibration and shock loads, high rotational speeds or relative rotation between the retained parts.

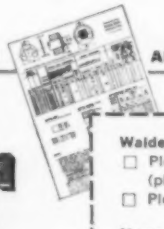
Series 5144 provides the following application advantages over conventional E-type fasteners:

1. **GREATER GRIPPING STRENGTH**—approximately five times greater than conventional "E-rings" of the same metal and thickness.
2. **HIGHER RPM LIMITS**—approximately 50% higher in most sizes.
3. **POSITIVE LOCKING IN THE GROOVE**—large corner radii or chamfers can be accommodated without separator washers.
4. **LOWER GROOVE COSTS**—because recommended groove tolerances have been increased, machining grooves for the series 5144 is less expensive.
5. **WIDER APPLICATION**—because series 5144 rings made of aluminum are stronger than conventional "E-rings" made of steel, the fastener may be used in applications where corrosion resistance or weight are factors.

Truarc Series 5144 Reinforced "E-rings" are available for shaft diameters from 3/32—7/16 in. in carbon spring steel, stainless steel, beryllium copper, aluminum, and phosphor bronze. They are available stacked on rods for high speed installation with Truarc applicating and dispensing equipment.

As in all Truarc rings, you get statistically controlled quality from engineering and raw materials to the finished product. Complete selections are available from leading OEM distributors in 90 stocking points throughout the U. S. and Canada. Design Engineering Service is available to you. Send us your blueprints. Let our Truarc engineers help you solve design, assembly and production problems... without obligation.

SEND FOR FREE SAMPLES AND ENGINEERING DATA



WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

☐ Please send me sample Reinforced "E-rings." (please specify shaft size)_____

☐ Please send me Engineering Data Sheet

Name_____

Title_____

Company_____

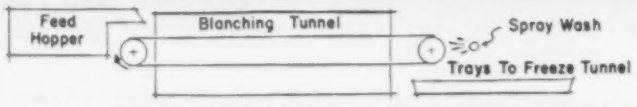
Business Address_____

City_____ Zone_____ State_____

PN-050

Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

Cambridge WOVEN WIRE BELTS



TYPICAL INSTALLATION FOR AUTOMATED BLANCHING AND WASHING

Continuous processing on open mesh belts increases product uniformity

Open mesh Cambridge Woven Wire Belts allow liquids, gases, cold or heat to flow freely through the belt and around the product for fast, uniform processing. Metal parts, food, chemical or ceramic products carried through wet, dry, hot or cold processing operations on endless Cambridge belts means increased production and lower operating costs. Here's why:

CONTINUOUSLY MOVING BELT ELIMINATES BATCH PROCESSING; belt to belt flow of materials reduces manual handling, labor costs.

ALL-METAL CONSTRUCTION IS HEATPROOF, RUSTPROOF; takes up to 2100° F. or sub-zero temperatures; resists corrosive attack; has no seams, lacers to wear or break.

SPECIAL SURFACE ATTACHMENTS AVAILABLE; raised edges, cross flights to keep product on belt during inclined movement.

Whether you design machinery for your own use or for resale, your Cambridge FIELD ENGINEER can explain how the many advantages of Cambridge belts make automated processing practical and economical. And, he'll recommend the belt size, mesh or weave—in the metal or alloy—best suited to your operations. Call now. He's listed in the classified phone book under "BELTING, MECHANICAL". Or, write for FREE 130-PAGE REFERENCE MANUAL giving mesh specifications, design information and metallurgical data.

The Cambridge Wire Cloth Co.

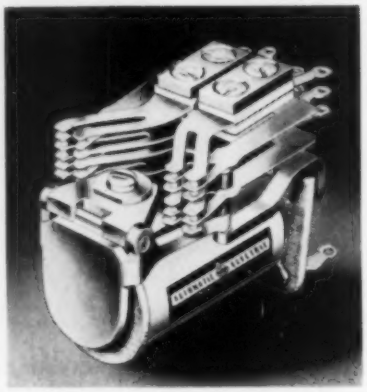
WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department P, Cambridge 5, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

to 60 sec are available with accuracy of 10% of nominal delay period. Delay occurs between application of current and relay contact pull-in. Choice of SPDT or 3PDT contacts. Rated 10 amp resistive. Operates on nominal input voltage of 28 v dc in ambient temperatures from —67 to 257 F. Service life is 100,000 cycles min. rate load. Typical model measures 1¼ x 1⅛ x 2¼ in. and weighs 5½ oz. **Tempo Instrument, Inc., 240 Old Country Rd., Hicksville, N. Y.**

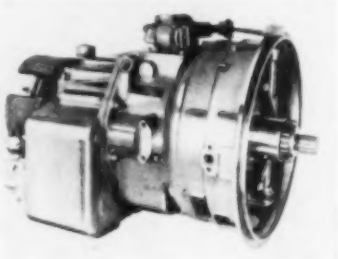
Circle 18, inside back cover



Miniature relay . . .

weighs 2 to 3 oz. Thick armature arms are said to retain proper stroke, even under heavy loading or severe operating conditions. Terminal spacing makes all terminal rows accessible for wiring. Designed for up to 150 v dc and 220 v ac. It has service life of 100 million to 200 million operations; is 2¼ x 1⅛ in.; height ranges from 1$\frac{13}{32}$ (for two-spring unit) to 1$\frac{33}{32}$ in. high (for 10-spring unit). Available in quick-acting; slow-operate; slow-release; slow-acting, slow-operate and slow-release; ac; and snap-action contact series. In various mountings. **Automatic Electric Co., Northlake, Ill.**

Circle 19, inside back cover



Automatic transmission . . .

combines hydraulic torque converter with a forward and reverse gear arrangement and a straight-through drive. Starting with a torque ratio of 5.5:1 in fluid drive, de-

(Continued on page 100)

"PONY POWER" MOTORS

that give stamina to your products

Lamb Electric ***fractional*** horsepower motors, like the small horses of the famed western-pioneer-day Pony Express, are developed for *stamina.*

Their dependability, and efficiency (optimum weight-size-horsepower ratio) are qualities that result from proper design and careful manufacture by personnel with many years of experience in the small motor field.

May we demonstrate how Lamb Electric Motors can bring these advantages—and also perhaps lower costs—to *your* products?

THE LAMB ELECTRIC COMPANY • KENT, OHIO

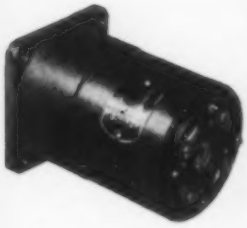
A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric — Division of Sangamo Company Ltd. — Leaside, Ontario

Lamb Electric

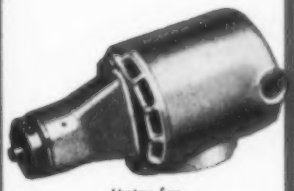
SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

A rugged high-torque, high-speed motor.



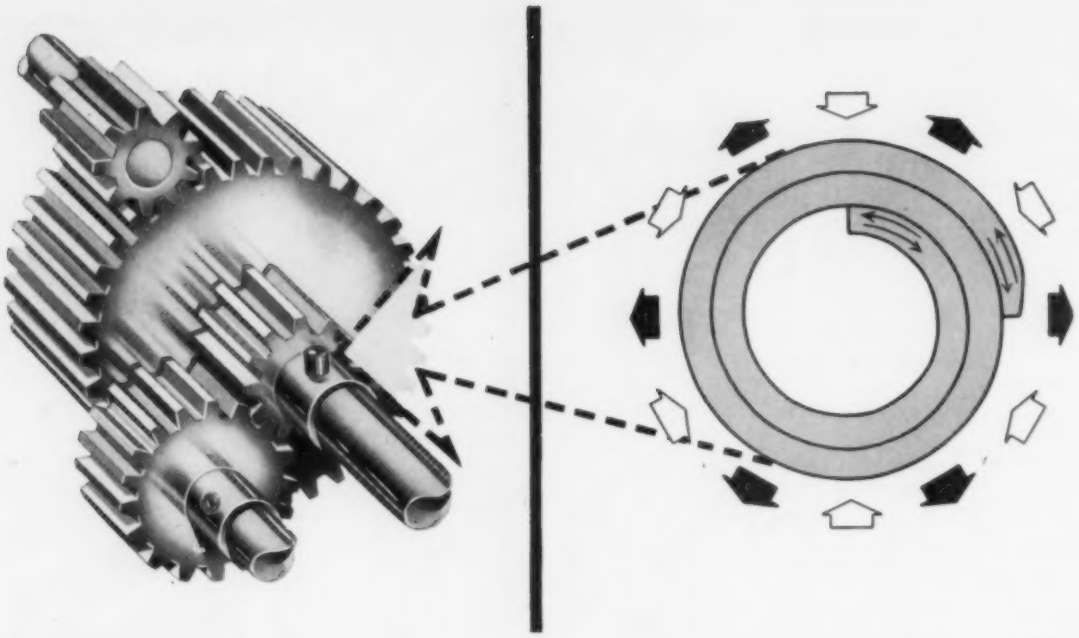
Radar voltage regulator gear motor.

Motor with efficient spur gear speed reducer.



Motor for high-speed grinder.

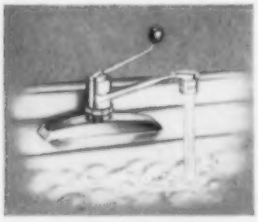
If you are interested in any of the above motors write and we shall be glad to send full information.



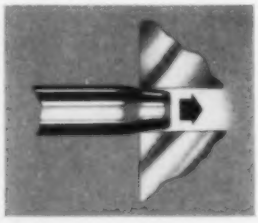
This spring pin's strength . . . comes from true spring *coils*

Full 360° radial spring action gives SPIROL true spring pins the ability to withstand repeated, heavy shock and vibration. When compressed, the unique spiral coils distribute stress evenly throughout the cross-section. There is *no stress concentration* at any point — no critical cross-section even with non-heat-treated metals. SPIROL's novel design gives you *all* the *cost-saving* benefits of a true spring pin.

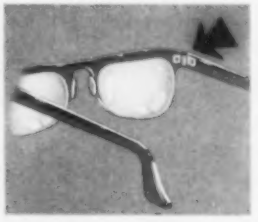
SPIROL gives these unique advantages



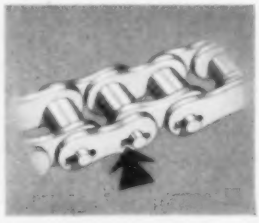
Non-heat-treated metals — such as low-cost brass, copper, nickel stainless steel — can be used in SPIROL true spring pins. Less resilient metals flex without failure, because there is no concentration of stress.



Wider hole tolerances eliminate reaming, reduce drilling rejects, cut production costs. Both plus *and* minus tolerances are allowed because of SPIROL spring pin's greater flexibility in expansion and compression.



Miniature sizes retain flexibility and strength of the spiral cross-section. SPIROL is the only spring-type pin made in miniature diameters: 1/32" — .039" — 3/64" — .052". Standard diameters up to 1/2" in stock.



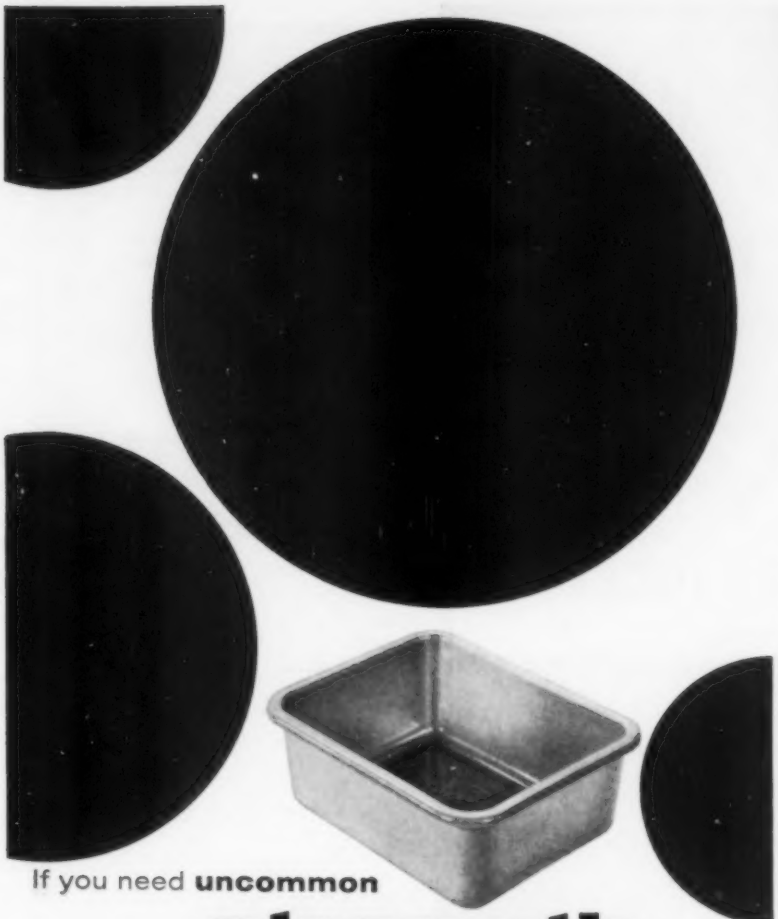
Shock resistance — extremely high resistance to shock, shear, and vibration permits use of "medium duty" SPIROL pins in the majority of applications. Heavy and light duty SPIROL pins are also available in stock.

FREE! *Write for complete literature on* SPIROL *spring pins, including price list.*

® SPIROL *the true spring* PIN

C. E. M. COMPANY • 108 SCHOOL STREET • DANIELSON, CONNECTICUT

Phone: PRescott 4-2411



If you need **uncommon**

strength...

make it with **GREX*** HIGH DENSITY POLYETHYLENE

Strength and sales appeal are twin imperatives in today's highly competitive housewares market . . . and GREX high density polyethylene gives a brand new measure of both!

This colorful dish pan, for example, is tough and rigid, can hold boiling water, will not warp, resists detergents and bleaches, and keeps its high gloss and attractiveness.

This same plastic makes crisper-trays, food containers and tumblers that never turn brittle, never shatter when frozen, and are easily cleaned.

These very qualities of durability recommend GREX for a limitless variety of uses: refrigerator parts that stand up under heavy loads and cold temperatures; sterilizable bottles; canisters and cups that don't break; automotive parts . . . toys . . . furniture drawers. You name it, and we'll show how *this versatile plastic means better products for you.*

**Trademark for W. R. Grace & Co.'s polyolefins. W. R. Grace & Co. produces GREX resin for a wide variety of uses, does not make the finished articles mentioned above.*

W. R. GRACE & CO.
POLYMER CHEMICALS Division
OFFICES CLIFTON, N. J. CHICAGO, ILL.
PLANT BATON ROUGE, LA.

GREX* in action

That dishpan on the left was molded from GREX high density polyethylene by an important new process . . . a Pre-Compressed Molding process which gives highly superior products, substantial dollar savings, and greater economy of operation.

Pre-Compressed Molding

In this new molding process, the gates contain valves that are closed as the injection takes place, and the material in the heating chamber, runners and sprues is compressed to the maximum pressure for molding. At optimum pressure, the valves are automatically opened and the plastic material pours into the cavity at high velocity. The valves are then closed and the finished part is ejected without sprues or gates—another plus feature. Multiple or single cavity molds may be valve-gated as well as individual runners in molds with an unusually large number of cavities.

It makes possible bigger, deeper molds and produces strain-free moldings with greatly improved physical properties, particularly in impact strength. Parts are freer from stresses, poor welds, trapped air and cracks . . . surface finish on parts noticeably improved.

Scrap losses are decreased. Because no gates or sprues need be trimmed, finishing cost are reduced. With lower machine temperature, warpage, material breakdown, shrinkage marks and color variations are virtually eliminated for all thermoplastic materials.

Since GREX high density polyethylene is suitable for elevated temperature applications and can be boiled and sterilized, it is particularly important that moldings be strain free and warpage be minimized. This new process almost invariably reduces molding cycle time for GREX and other thermoplastics—usually one-half to two thirds!

Putting this Process to Work for You

GRACE's Polymer Chemicals Division has been licensed exclusively under patents held by Columbus Plastic Products, Inc., Columbus, Ohio, and in turn GRACE will sub-license plastic molders so that the benefits of this new process may be made widely available.

For more information write for your copy of "The Story of Pre-Compressed Molding."

ANNOUNCING

an important heat discovery for design engineers

NOW!

as much heat concentration in 1/5 the space!

The New WATLOW FIREROD® CARTRIDGE HEATER

a new standard in watts densities ...and longer operating life!

Never before in cartridge heating history has so much heat been available in so small a unit – 5 TIMES MORE HEAT IN THE SAME SPACE! Or as much heat in 1/5th the space. Here is new design flexibility for many heretofore difficult or impossible applications. In addition, WATLOW FIREROD Cartridge Heaters will give you much longer life than ordinary cartridge heaters.

The FIREROD is available in lengths from ⅞" to 12", in diameters of ⅜" and ½".

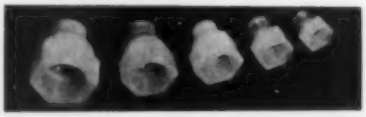
FREE ILLUSTRATED LITERATURE *describes operation data, tests, styles, etc. Write for your copy today!*

WATLOW

ELECTRIC MANUFACTURING CO.
1392 Ferguson Avenue
Saint Louis 14, Missouri

pending on application, and graduating down through direct drive or lock-out range, unit delivers an uninterrupted flow of power to driving axle. Vehicle acceleration from a dead start regardless of load is directed entirely through torque converter without gearing. As transmission approaches a 1:1 torque ratio, a full-power shift is automatically made to direct drive. Nominal torque rating is 400 to 650 ft-lb. Oil capacity, including reservoir, is 10 gal. Over-all length is 30⅞ in. **Dana Corp., 4100 Bennett Rd., Toledo 1, Ohio.**

Circle 20, inside back cover



Nylon flare nuts . . .

seal tightly and can be temperature cycled to 300 F without leaking. Nuts resist loosening by vibration and will not shear plastic tubing when overstressed. Specially designed for sealing nylon pressure tubing to a metallic flare body. Nuts are standard SAE 45° flare recommended for systems with pressure of 250-psi max. By yielding under tension in the area of pressure on the flare, provides a firm gripping action to compensate for flow tendencies of the tubing on temperature cycling. Nuts absorb vibration. Presently available in ⅛, ⅜, ¼, ⅝ and ½-in. sizes. **Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Penna.**

Circle 21, inside back cover

High-speed transmission belts . . .

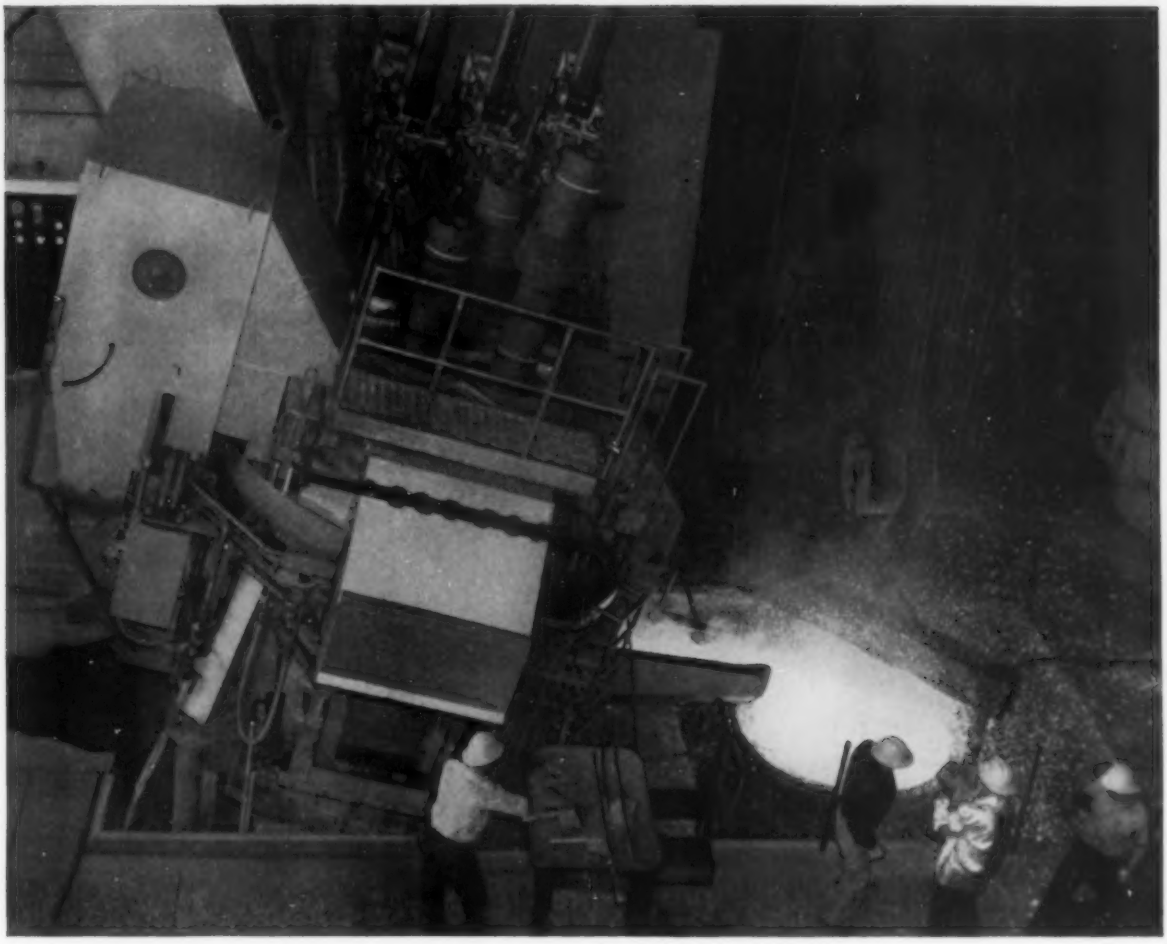
are reported to remain cool and free from frictional heat, regardless of speed, load, pulley size or machine design. The endless belts are uniformly constructed to equalize stress and eliminate vibration. They are treated to prevent slippage, and to protect against effects of oil, moisture and heat, and bonded to eliminate internal and surface friction even when operated at high speeds for extended periods. They drive spindles up to 100,000 rpm. Belts have less than ¼ the stretch of conventional belts. Especially designed for high speeds and for reverse action of small-dia pulleys. Max efficiency is also claimed at average speeds and over larger pulleys. **Globe Woven Belting Co., Inc., 1400 Clinton St., Buffalo 6.**

Circle 22, inside back cover

Variable-speed control . . .

serves as main governor on small engines and as an over-speed governor on larger engines. Torque capacity is 30 in.-lb at 1200 rpm. Constant-speed range is 500

(Continued on page 124)



Wide variety of alloy and stainless steel products made possible with Standard's new electric melting furnace

With installation of our new electric furnace, we at Standard are now equipped to give you even better service—even faster deliveries—and much greater variety of steel analyses—than ever before.

These expanded facilities provide you with an in-plant source of forgings, castings, rings and flanges from virtually any specialty alloy steel, including bearing grade steels, tool steels, high temperature steels, and stainless steel.

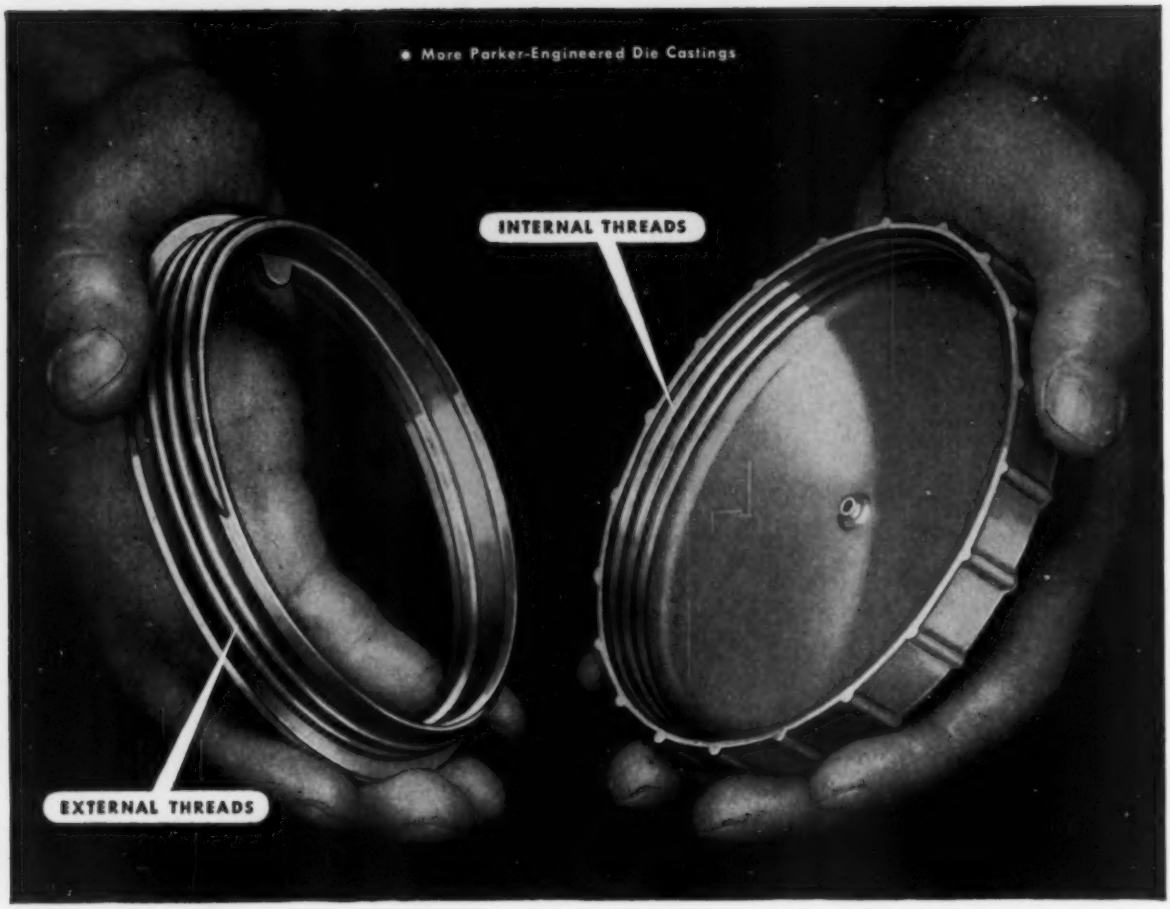
Discuss your next requirements with us. You will appreciate our service as well as our quality. Write Dept. 4-E.

Standard Steel Works Division

BALDWIN · LIMA · HAMILTON

BURNHAM, PENNSYLVANIA

Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes



From ONE Die: TWO Parts... THREE Savings!

PARKER SALES ENGINEERS

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street
CHICAGO 49, Ill.
Ollie J. Berger Company • 2059 East 72 Street
CINCINNATI 14, Ohio
William H. Broxterman • 2430 Central Parkway
DETROIT 35, Mich.
Hodgson-Geisler Co. • 18917 James Couzens
GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street
LONG BEACH 11, California
R. W. Fletcher • 2803 Loomis Avenue
MINNEAPOLIS 16, Minnesota
O. R. Kreutziger • 6524 Walker Street
PHOENIX, Arizona
Fred B. Larsen • 6108 North 11 Avenue
ST. LOUIS 8, Mo.
Frank May • 4378 Lindell Boulevard
SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.
WILTON, Conn.
Girard L. Palmer • Belden Hill Road
WINTER PARK, Florida
Duane P. Davis • 110 South Orlando Avenue
Box 26

These two mating parts, including the threads, are cast simultaneously in the same die. The result—three savings:

1—One die instead of two *saves die cost*

2—Casting two parts at one time in the same die *saves production time*

3—Precision casting of the perfectly mated threads with no parting line *saves machining cost*

Together, these three savings result in a substantially lower cost per piece. Just another example of the way Parker-engineered die castings save you money.

Parker has been a leader in die casting for over 50 years—an old hand with new ideas. This skill and experience can solve problems — and save money—on *your* component parts. Just call the nearest Parker sales engineer or write the factory direct.

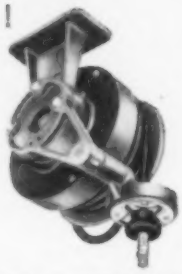
Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure ALUMINUM and ZINC die castings POWDERED METAL PARTS

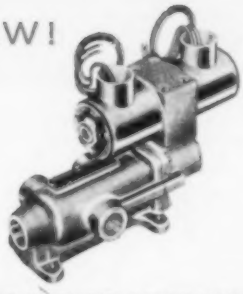
SCHRADER ADDS MORE NEW AIR CONTROL PRODUCTS TO GIVE YOU EVEN WIDER SELECTION

NEW!



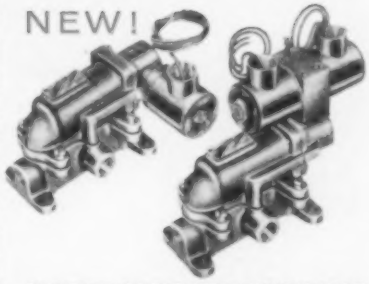
HOSE REEL FOR AIR TOOL SUSPENSION —Saves duplicate equipment and maintenance. Saves time on high speed production. Spring tension counterbalances air tools. Powerful spring automatically takes up tool.

NEW!



DOUBLE SOLENOID 4-WAY VALVES — Now double solenoid 4-way action available in full series . . . voltage-wise, port size, flow capacity. Permits longer dwell time in either position without continuous electrical energy.

NEW!

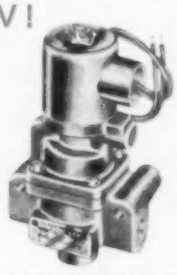


SUB-BASE SINGLE AND DOUBLE SOLENOID VALVES — Greater versatility. You don't have to disturb the piping for service. Reduces "down time" to absolute minimum. Complete series: voltages, sizes, capacities.

NEW!

PILOT OPERATED SUB-BASE 4-WAY VALVES — Sturdy cast meehanite sub-base contains all ports for piping air. Permits removal of valve mechanism for service without disturbing piping. Complete new series!

NEW!

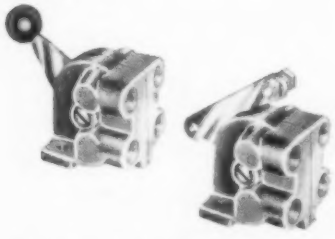


NEW! 3-WAY SOLENOID VALVES—Simple 3-way action available in full series—voltage, port sizes, flow capacities. By shifting pilot chamber head 90°, normally open changes to normally closed, and vice versa!

NEW!

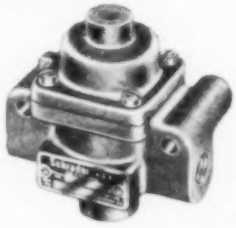
2- AND 3-WAY FOOT VALVES — With right angle ports. Give convenience and control with simplest installation. Mount directly on floor. ⅜" N.P.T. Sturdy, compact, and *versatile*. Take minimum space.

NEW!



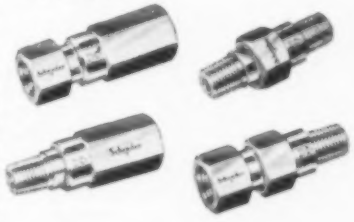
SLIDING SEAL VALVES FOR PIPED EXHAUST — Complete series! 2, 3, 4-way types. ¼" N.P.T. ports. Hand or mechanical lever. Compact, minimum working parts.

NEW!



3-WAY PILOT VALVES — Complete new line. Normally open or normally closed types. Ideal for single-acting cylinders. Simple, neat, sturdy. May easily be converted to solenoid.

NEW!



CHECK VALVES—Thread combinations now in complete series in spring-loaded check type. Pinpoint your needs. Amazingly compact, relative to large flow capacity. Capacity 35 cu. ft.

Schrader®
a division of SCOVILL

Use the full Schrader line to do your air control selecting. Your Schrader distributor can help you pinpoint what you need. For more data write:

A SCHRADER'S SON • *Division of Scovill Manufacturing Company, Incorporated*
477 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR PRODUCTS

IT PAYS TO HAVE HUBBELL GOOD CONNECTIONS

FROM ASSEMBLY START TO FINISH, HUBBELL PRECISION SCREWS ARE USED IN THE TYPE J2S WATTHOUR METER MANUFACTURED BY SANGAMO ELECTRIC COMPANY, SPRINGFIELD, ILLINOIS.

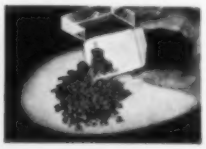
SECURED WITH HUBBELL PRECISION-QUALITY MACHINE SCREWS

Each of the twenty-five Hubbell machine screws shown at left are vital components in this Sangamo Type J2S Watthour Meter. Each shares the responsibility for keeping the assembly operation flowing smoothly, and each makes its own contribution to the overall dependability and accuracy of the unit. All along the line the advantages of Hubbell precision screws pay off. Clean threads, well formed heads, deep, clean slots, uniform size . . . all of these quality features help to secure Sangamo quality and reduce assembly costs.

Here again, experience proves that the finest materials and components are always *lowest in cost to service*. Are you putting this time-tested principle into practice? Start today by specifying Hubbell quality fasteners. Prices and delivery on request. Simply send blueprint or sample of the item.

. . . and don't overlook these premium miniatures

. . . the finest obtainable . . . available in steel, stainless steel or brass; and in head styles and sizes to meet your requirements.

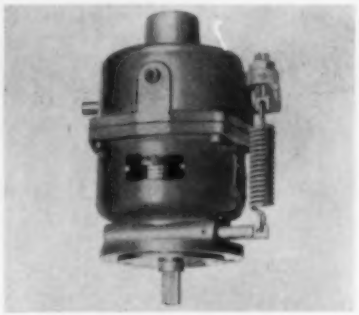


HARVEY HUBBELL, INC.

HIGHEST QUALITY WIRING DEVICES • MACHINE SCREWS

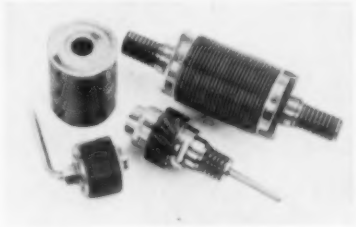
OVER 60 YEARS' EXPERIENCE in the manufacture of highest quality, rolled thread machine screws and special cold headed parts

MACHINE SCREW DEPARTMENT BRIDGEPORT 2, CONNECTICUT



to 2400 rpm; variable-speed range, 500 to 1440 rpm. It can be supplied with a permanently attached flexible drive. Mechanical, flyball type of governor is finding application on diesel and gasoline engines and on steam turbines in services which vary from pumps and compressors to electric generating sets. **Farris Pickering Governor Co., Inc., 705 Commercial Ave., Palisades Park, N. J.**

Circle 23, inside back cover



Welded metal bellows . . .

range from ¼ to 18 in. OD. Said to be 25% to 50% smaller than conventional bellows. Can be designed with flat, spherical, stepped and other specially shaped plates as thin as 0.003 in. with ±0.0001 tolerance. Bellows are built of individually welded plates that may have many more convolutions per in. of length than conventional hydraulically formed bellows. This, coupled with the inert gas welding process and resistant characteristics of special metals used, results in a controlled effective area and a lower spring rate. **Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., 155 Hill St., Milford, Conn.**

Circle 24, inside back cover

Hydraulic pumps and motors . . .

for continuous service pressures to 1500 psi are available in seven models, with pump capacities from 1.2 to 14.2 gpm. Pumps and motors are provided for speeds of 3600 rpm. Both use involute spur gears of heat-treated alloy steel. Construction includes heavy-duty antifriction bearings; hard double-wear plates of a special bronze alloy; double-lip shaft seals; heat-

(Continued on page 126)

Want Control for Water Heaters • Processes Heat Exchangers • Compressors Diesel and Gas Engines?

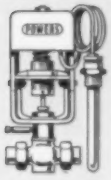
call POWERS

FLOWRITE®
One of Powers Premium Quality Diaphragm Control Valves. They're simple, sturdy and dependable.

Over 60 Years of Temperature and Humidity Control

(c28c)

You Will Insure Better Temperature Control IF—



you use the right type regulator and proper size control valve. Whether you require a self-operating regulator shown at left or the ACCRITEM featured here . . . you can get them both and other types from Powers.

Use our 65 YEARS of Experience and engineering know-how to help you select the right type of control. Call our nearest office or write us direct.

Powers ACCRITEM Temperature Regulator and FLOWRITE Valve—the right combination for many control problems where pressure and load conditions fluctuate widely, also for control of large size valves.

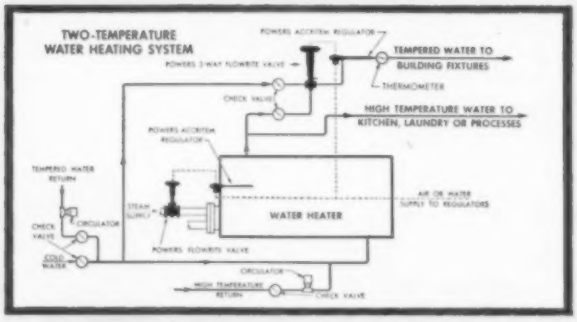
Over 50 Years Experience making this type of regulator

Control Point easily changed

Air or water operated

Ranges 50 to 250°F—150 to 350°F

VALVES: Available in a variety of body types and inner valves.

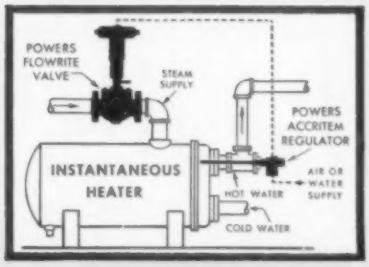


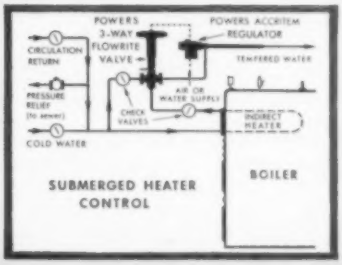
ACCRITEM® TEMPERATURE REGULATOR

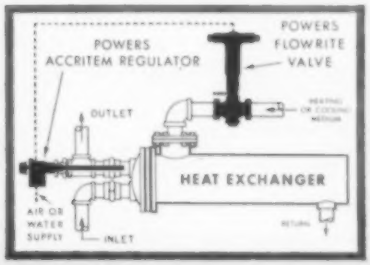
Gives Close Control and Years of Dependable Service.

- Has Adjustable Throttling Range and Calibrated Dial.
- Simple, Durable Construction assures years of trouble-free service.
- Easy to Install • Direct or Reverse Acting, reversible on the job.
- Small Size: Regulator head is 2⅞" wide, 3⅛" high, bulb is 12" long wtih ½" IPS Connection.

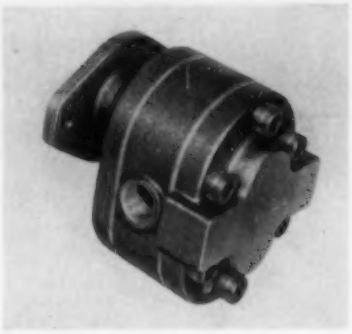
☛ *Write for Bulletin 316* • **Powers SERVICE is available in 85 Cities in U.S. and Canada.**





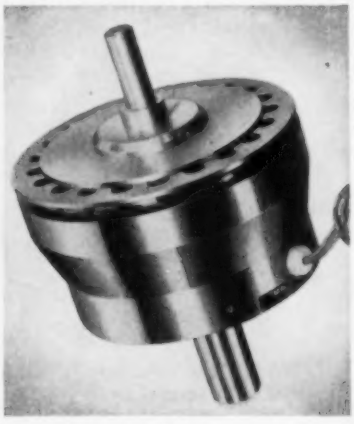


THE POWERS REGULATOR COMPANY | Skokie, Ill. • Offices in Chief Cities in U.S.A. Also Canada and Mexico • See your phone book



treated alloy steel shaft and heavy-duty outboard ball bearings for overhung shaft loads. **Tuthill Pump Co., Dept. RP, 963 E. 95th St., Chicago.**

Circle 25, inside back cover



Hysteresis clutch . . .

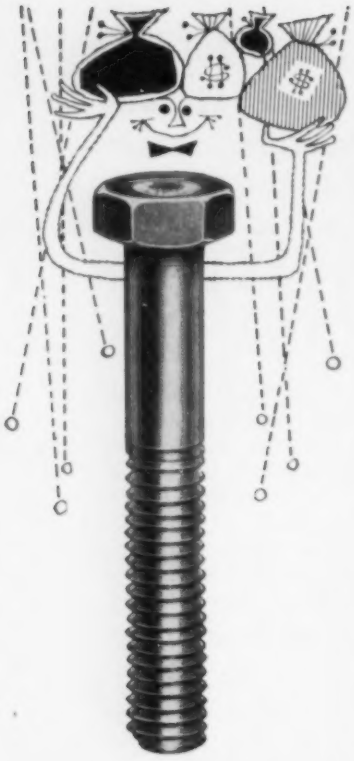
employs a stationary coil, eliminating frequently objectionable characteristic of slip rings. Max torque rating has been increased about 30%, but clutch requires no additional mounting space over previous unit. At present, clutches of 140 oz-in. torque rating are immediately available. Torque may be controlled from zero up to max rating of unit, relatively independent of slip-speed characteristics, according to clutch control current setting. At a given control current, slip torque at stall will be almost the same as slip torque at very high dynamic slip speeds, except for minor non-linear components of eddy-currents and viscous bearing drag. Clutching action is magnetic. **Magtrol, Inc., 240 Seneca St., Buffalo 5.**

Circle 26, inside back cover

In-line filter . . .

handles hydraulic oil from 10 to 25-gpm capacities at low pressure drop. Wire cloth filter is available in mesh sizes from 30 to 100. Cartridge is removable for cleaning. Over-all length is 6½ in.; head dia is 4½ in.;

(Continued on page 128)



YOU'LL BE DOLLARS AHEAD WITH ALCOA ALUMINUM FASTENERS

You save dollars when you use Alcoa® Aluminum Fasteners . . . the lowest cost, corrosion-resistant fasteners available. They are a perfect color match for the aluminum products you make, and they insure against both galvanic and atmospheric corrosion. For your requirements, call your nearest Alcoa sales office. Alcoa Aluminum Fasteners . . . in all standard types and sizes . . . are readily available from the complete stocks of your local Alcoa distributor. Look in the Yellow Pages of your telephone directory. Alcoa is a "natural" for specials, too!

ALCOA ALUMINUM FASTENERS

ALCOA THEATRE
Exciting Adventure
Alternate
Monday Evenings.

Your Guide to the Best in Aluminum Value

FREE . . FACTS, SAMPLES . . FREE . . FACTS

Aluminum Company of America
2247-E Alcoa Bldg., Pittsburgh 19, Pa.
Gentlemen: Please send complete specification data and samples of Alcoa Aluminum Fasteners.

Name_____
Title_____
Company_____
Address_____

enflex HAS THE ANSWER TO YOUR FLEXIBLE TUBING PROBLEMS

It's "Flexineering" — the technical help of Penflex engineers on your specific design, application and installation *plus* the "know how" to supply just the right flexible tubing for your need.

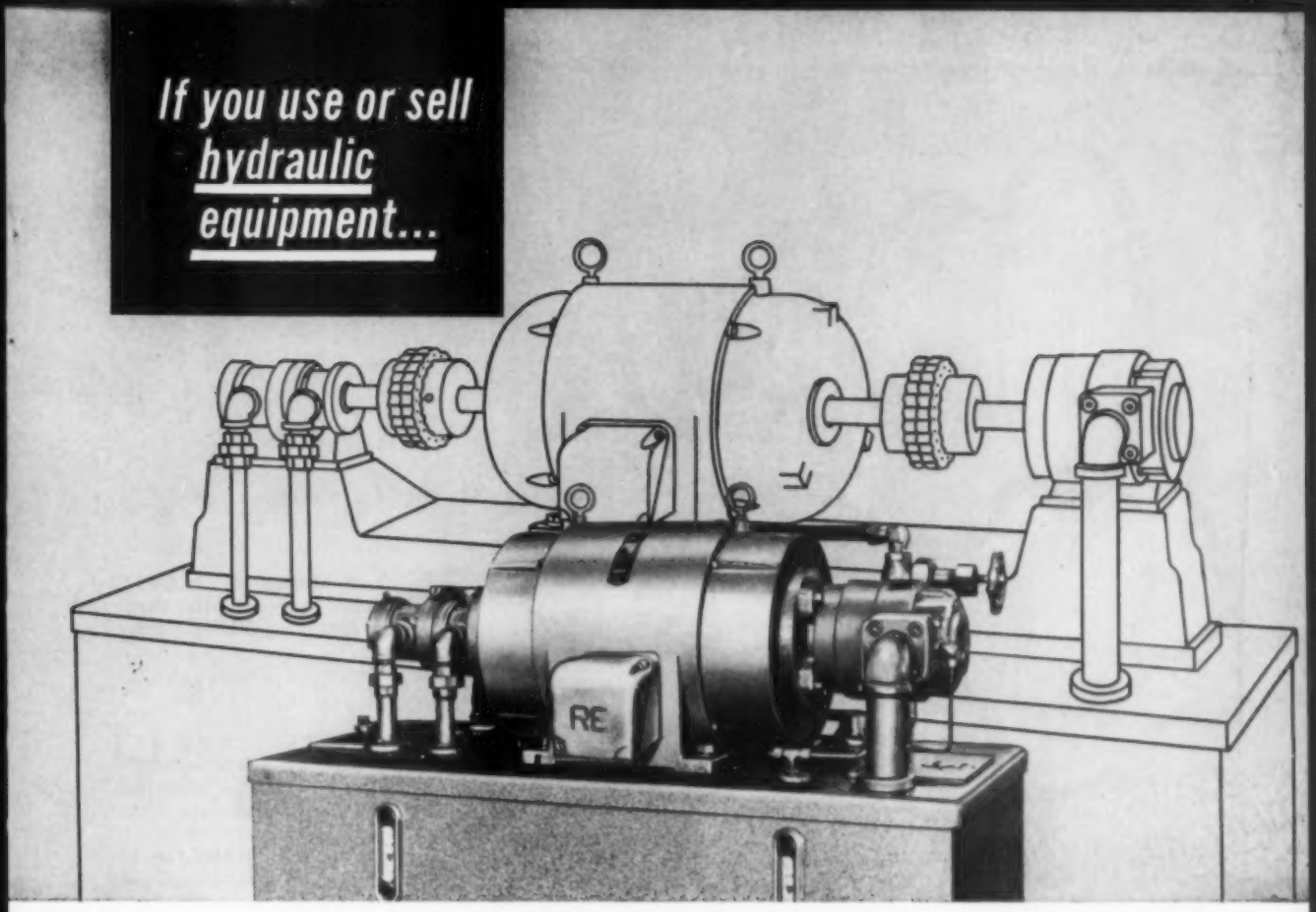
If you want to convey air, water, steam, gases, volatiles; granular, abrasive or light solid materials . . . or require flexible connections that "give" with vibration, expansion, contraction, come to Penflex. Its complete line of bronze, galvanized and stainless steel, corrugated and interlocked tubing is rugged . . . safe at high pressures and temperatures, free from metal fatigue. All types, all sizes in ⅛" to 24" I.D.

GET YOUR COPY

Write Pennsylvania Flexible Metallic Tubing Company, Inc. 7238 Powers Lane, Phila. 42, for "Flexineering" helpful book on tubing.

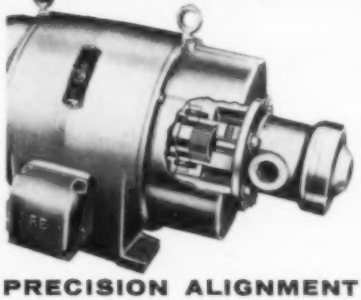
PENFLEX
TIGHT AS A PIPE BUT... FLEXIBLE

If you use or sell hydraulic equipment...



...cut space needs almost 50% with REULAND spline-coupled hydraulic pump mount motors!

Pump and motor become *one* with the new Reuland spline-coupled hydraulic pump hook-up. The pump shaft is connected directly to the motor's shaft *inside the motor*. Flexible couplings are eliminated... pump mount platforms are eliminated... and the tank length can be reduced because almost 50% less mounting area is required. Compact appearance is beautiful.



SPEEDY INSTALLATION

Pump-to-motor hook-up is merely a matter of seconds. All you do is slip the spline coupling onto the pump shaft...and attach the pump to the endbell. This spline coupling is supplied with the motor and is precision mated for each make of pump. There's no time wasted tinkering around... takes only a fraction of the ordinary time.

PRECISION ALIGNMENT

Alignment is perfect *automatically* whether the installation is made out in the field or on the production line. This permits even unskilled workmen to handle this simple task without error. Also, by hooking the pump up at the point of bearing support, within the motor, vibration is reduced to a new minimum. Operation is smooth, quiet.

COSTS LESS...SAVES INSTALLATION LABOR... FITS ALL PUMPS

The Reuland spline-coupled unit is priced lower than a conventional set-up... saves you extra money by reducing installation costs. What's more, we can supply it to fit any make of pump you may be using. So sure are we that it will be of help to you, we are offering to engineer a demonstration unit to *your* equipment, without the slightest obligation. These units are our best salesmen.

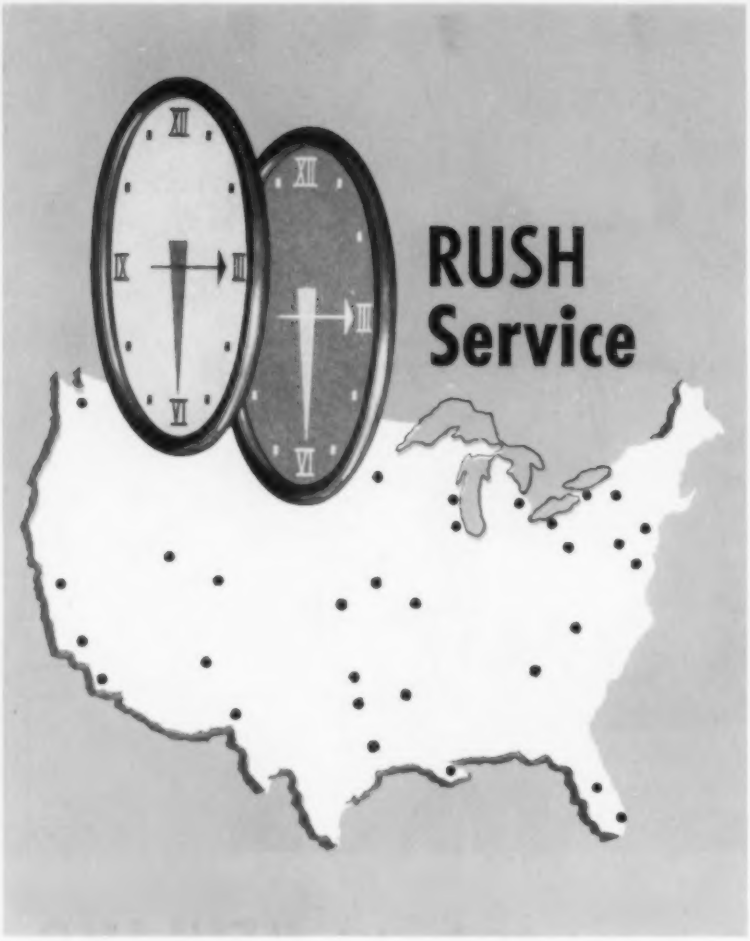
OUR NEW GENERAL CATALOG WILL COME IN HANDY-SENT FREE ON REQUEST.

MODERN POWER FOR MODERN-DAY PRODUCTS

REULAND MOTORS

REULAND ELECTRIC COMPANY
WESTERN DIVISION: Alhambra, California
EASTERN DIVISION: Howell, Michigan
DISTRIBUTORS IN ALL PRINCIPAL CITIES

*Trademark Registered



immediately from stock
Precision "O" Rings
in 300 sizes

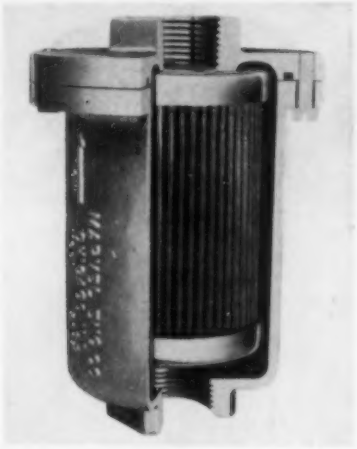
Rush "O" Ring requirements? Call Precision! Fast service for Industrial Grade and Military Specification "O" Rings that are **right** for your product. Shipments from Dayton or from the Precision Branch Stocks near you.

For special "O" Rings, face-to-face seals or rubber-bonded-to-metal parts ask for the Precision Sales Engineer. He can help you get the **right** product design . . . the **right** quality . . . the **right** delivery.

Specify Precision—first in Quality

Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialists

Dept. 3, Oakridge Drive, Dayton 7, Ohio Canadian plant at: Ste. Thérèse de Blainville, Québec



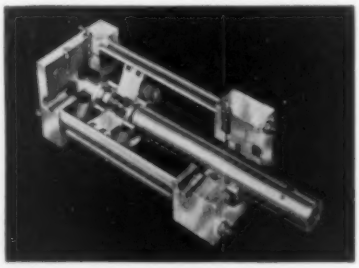
case dia is 3⅛ in. Openings are 1 in. NPTF at both ends. Deliveries from stock. **Marvel Engineering Co., 7227 N. Hamlin Ave., Chicago 45.**

Circle 27, inside back cover

Variable-speed drive . . .

is integrally combined with a right-angle gear reducer in drip-proof and totally enclosed construction, in speeds from 360 to 5.5 rpm and speed variations from 2:1 to 10:1. Positive pulley construction of drive provides infinitely variable speed and maintenance of speed, while the right-angle gears transmit the power. Positive oil seals on both input and output shaft of reducer permit units to be operated horizontally or vertically, shaft up or down, without oil leakage. Suited for applications where output shaft must be at right angles to transmission. **Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22.**

Circle 28, inside back cover



Fluid power cylinders . . .

in 23 models, each in 10 bore diameters, are recommended for air pressures of 150-psi max and oil pressures of 500-psi max. Honed brass tubing and bronze floating-cushion bushings are used. Built-in check valves provide instantaneous reversal. Replaceable cartridge-type piston rod bearings can be serviced without dismantling cylinder. Available in seven standard

(Continued on page 130)

tailor-made for You

. . . and every one a perfect fit

No Sir, no ready-made here. Emerson-Electric motors are custom-engineered for your product . . . *designed* for you, *produced* for you and *priced* for you. It is no longer necessary to design your product around a *standard* motor. Emerson-Electric engineers will work with you through every stage of development. You get the product you want with a motor that EXACTLY suits your purposes . . . a custom-engineered motor.

Call, wire or write Dept. M-309 today, The Emerson Electric Mfg. Co., St. Louis 21, Mo.

EMERSON-ELECTRIC
of St. Louis

Since 1890

MEET THESE 4 CHALLENGES

NEW INCONEL-X
Sylphon Bellows

Searing heat. Bitter cold. Extreme pressure. Severe corrodents. Jarring shock and vibration. Now you can successfully meet these challenges in aircraft, and missile applications. New Inconel and Inconel-X bellows, perfected by Fulton Sylphon, give you important advantages in designing controls, valves, joints, ducts and other components.

These nickel-chromium alloy bellows possess exceptional strength and resistance to corrosion at high temperatures. Age-hardening Inconel-X offers superior stability and "hysteresis" factor. Durability tests indicate three times the life expectancy of similar bellows made from stainless steel. Can be made in sizes from 1⅝" to 12" O.D. . . . single or multi-ply construction . . . with *complete* assembly if desired. Engineering assistance for any specific application available on request.

*Depending on application.

Mr. Controls®

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tenn.

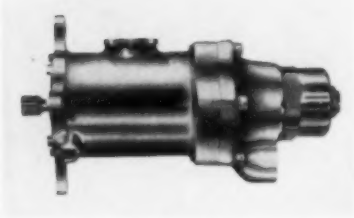
mountings. Double end rods, internally and externally threaded, are available on all models except blind end flange and clevis mountings. Cushioning can be provided in all cylinders, degree varied by adjusting screws. **Rivett, Inc., Brighton 35, Boston.**

Circle 29, inside back cover

High-amperage switches . . .

are designed so that their normally inert position is on. These high-current-capacity momentary contact switches are rated 10 amp, 125 v ac and 5 amp, 250 v ac. Said to be no larger in size than standard lower capacity switches, series is applicable to safety switches, door switches, limit switches and similar applications where higher current capacity is required. Available in spade, solder, screw or wire lead terminals. Mountings include threaded nipple, snap ring or fastener. UL-listed. **Alcor Mfg. Co., 4444 W. Roosevelt Rd., Chicago 24.**

Circle 30, inside back cover



High-temp hydraulic pump . . .

has a capacity of 3 gpm and will operate to 450 F. The stainless steel and special alloy pump is constructed to operate in ambient temperatures to 700 F. **Watertown Div., New York Air Brake Co., Starbuck Ave., Watertown, N. Y.**

Circle 31, inside back cover

O-ring tube fitting . . .

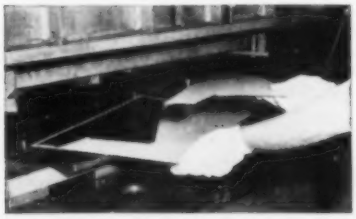
for vacuum, air and hydraulic systems seals by means of a standard O-ring. A split tapered sleeve holds tubing in place; then clamping nut is drawn up. Nut fits loosely on tubing: higher the pressure, greater the grip of tubing and greater the sealing action. There is no metal-to-metal seal. Fittings come in connectors, unions, elbows, tees, crosses

(Continued on page 132)

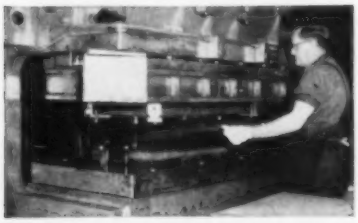
"Perfect finish retained"
"This reject problem is licked"
"Downtime certainly has been reduced"
"Nothing more to be desired in quality and finish"
"Stands up very well under standard fabricating methods"

K. R. Craft, Vice President, The Seeburg Corp., Chicago, with one of the company's famous juke boxes. The brilliant reflectivity and durability of Nickeloid pre-plated metals is an important factor in the product's eye-catching good looks.

NICKELOID METALS SAVE 4 PRODUCTION STEPS— REDUCE REJECTS FOR THE SEEBURG CORPORATION



Standard fabricating methods are used to stamp and form juke box trim. Nickeloid Metals eliminate machinery tie-up; rejects are less than 1%.



Stamping Nickeloid chrome steel, protected with Mar-Not adhesive-backed paper which is easily peeled off. Finished part will need no polishing.

Pre-Finished Design Material is Easily Worked With Standard Fabricating Methods

The Seeburg Corporation uses Nickeloid *pre-plated* chrome steel to achieve functional beauty and attention-value . . . economically. Before switching to Nickeloid, the company did its own cleaning, plating and buffing. The job required four — sometimes five more operations than are now necessary. According to Mr. Craft, "The tremendous cost of plating and buffing was not only more expensive and much more time consuming, but the finished product had to be inspected, and the rejections on plated and buffed metals was very much higher than it is with Nickeloid. Economically, the Nickeloid Metals have proved themselves in production."

Using standard fabricating methods, Nickeloid Metals need only be stamped and formed — then assembled. By capitalizing on this pre finished *method* of production, this leading manufacturer has eliminated the machinery formerly required for plating, polishing and buffing — saved four or five production steps, and is producing a better end product *with less manpower*. Can you use these advantages in *your* operation?

WRITE TODAY FOR FREE LITERATURE

NICKELOID METALS SINCE 1898

AMERICAN NICKELOID COMPANY

PERU 4, ILLINOIS

new way to make products better, more efficient...

ACE PRECISION NYLON BALLS

Precision manufactured from DuPont Nylon Resin to close tolerance of ±.001 on diameters and .001 on sphericity, Ace Nylon Balls give design flexibility and production economy. Light in weight... tough at low temperatures... stable at high temperatures... resistant to corroding chemicals such as sulphuric acid, etc.... almost abrasionproof... these mass-produced balls have hundreds of industrial applications. Come in 14 standard sizes from ⅛" to ¾".

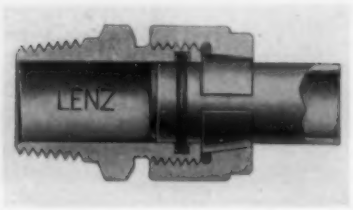
Complete facilities for fabrication of plastic parts for all industries. Estimates submitted promptly on receipt of blueprints or specifications.

Write for samples, bulletin, price list, TODAY.

EXTRUSION MOLDERS AND FABRICATORS

ACE PLASTIC COMPANY
91-56 Van Wyck Expwy., Jamaica 35, N. Y. JAmaica 3-5500

TOUGH and tiny
Save SPACE
and WEIGHT with
The A. W. HAYDON COMPANY'S unique Line of
RELIABLE SUB-MINIATURE REPEAT CYCLE TIMERS
TINY!
1 x 2 inch cross section
6½ ounce basic weight
Up to 10 switches
TOUGH!
Temperature: 54° C. to 85° C.
Vibration: 500 CPS, 10g
Shock: 30g
Hermetically Sealed Housings! Direct Current or 400 Cycle Operation! Custom Designed to Meet Military Specifications!
Write for Bulletin AWH-RC-301.
A.W. HAYDON Company
221 NORTH ELM STREET, WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices



and bulkhead connections in tube sizes from ¼ to 2 in. OD. In cadmium-plated steel, black phosphate finish or stainless steel. **Lenz Co., Box 1044, Dayton 1, Ohio.**

Circle 32, inside back cover

Manifold mounted valves . . .

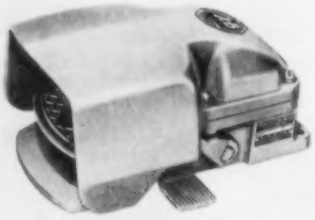
for air and hydraulic service provide compact multiple-valve installation with a common subplate for automation controls on specialized machine tools and other equipment. Valves are nominal ¼-in. size, available in two, three and four-way, with solenoid, pilot or manual control. All spool types are available. Mount on 2-in. centers and up to six units can be mounted on one manifold. **Beckett-Harcum Co., Wayne Rd., Wilmington, Ohio.**

Circle 33, inside back cover

Top-plate conveyor chain . . .

is said to give up to 35% more rail load-bearing area than other conveyor roller chains of the same general type. It permits use of wider supporting rails so the load can be distributed over a greater area. Top plate is welded to chain links by projection welding, forming a permanent metal fusion as strong as metal itself. Chain is detachable at any point as each link is a connector. **Diamond Chain Co., Inc., 402 Kentucky Ave., Indianapolis 7.**

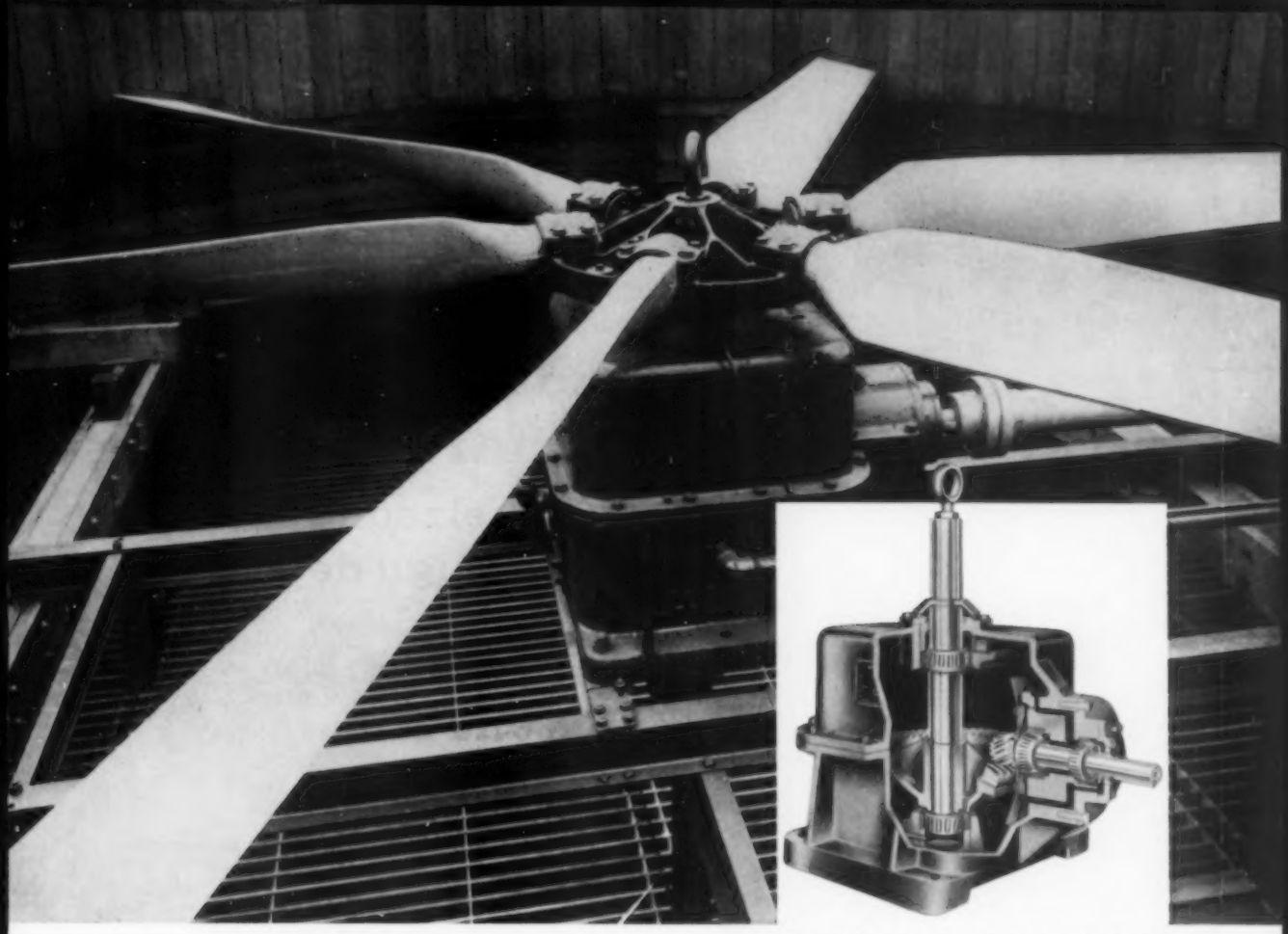
Circle 34, inside back cover



Heavy-duty foot switches . . .

are available in watertight, oiltight and explosion-proof enclosures, with snap-action, spring return contact mechanism. Foot-switch base and cover are die-cast aluminum. Offered in styles to provide a guard extending over top of foot treadle, a guard covering top and sides of treadle,

(Continued on page 135)



This spiral bevel gear combination permits the flexibility required to meet rugged 24-hour service while providing an economical, self-contained unit which requires practically no maintenance.

How to obtain help when you design bevel gear assemblies

The men who designed the gear reducer for the cooling tower fan shown above were assisted in many ways by Gleason engineers.

Cooling tower fan operation is generally recognized to be one of the most severe tests to which a gear reducer can be subjected. These towers demand a gear system that can operate twenty-four hours a day, three hundred and sixty-five days a year if necessary.

The gear reducer is subject to heavy loads and lies in the path of moist, corrosive air streams.

The gear drives for these cooling tower fans are subject to heavy loads and lie directly in path of moist, corrosive air streams.

Here is what the customer and Gleason engineers developed.

A spiral bevel drive of 19 x 76 combination and 2.5 DP. With spiral bevel gears the tooth bearing is localized which assures smooth and quiet operation and permits some mounting deflections without concentrating the load dangerously near either end of the tooth.

The use of this gear design also allowed the flexibility required to fit the fan unit into the over-all design of the tower and to produce an economical, self-contained unit which requires little or no maintenance.

Next, our engineers produced and tested prototypes of the design which the customer in turn tested in the final product.

Our engineers can also help you select proper mountings for such gear assemblies and advise you on such details as lubrication.

If you would like to take advantage of this service, write us the next time you have a problem involving bevel or hypoid gear systems. Furnish data covering type of application, loads and speeds and prints of the mountings. We would be pleased to assist you in the selection of your gears.

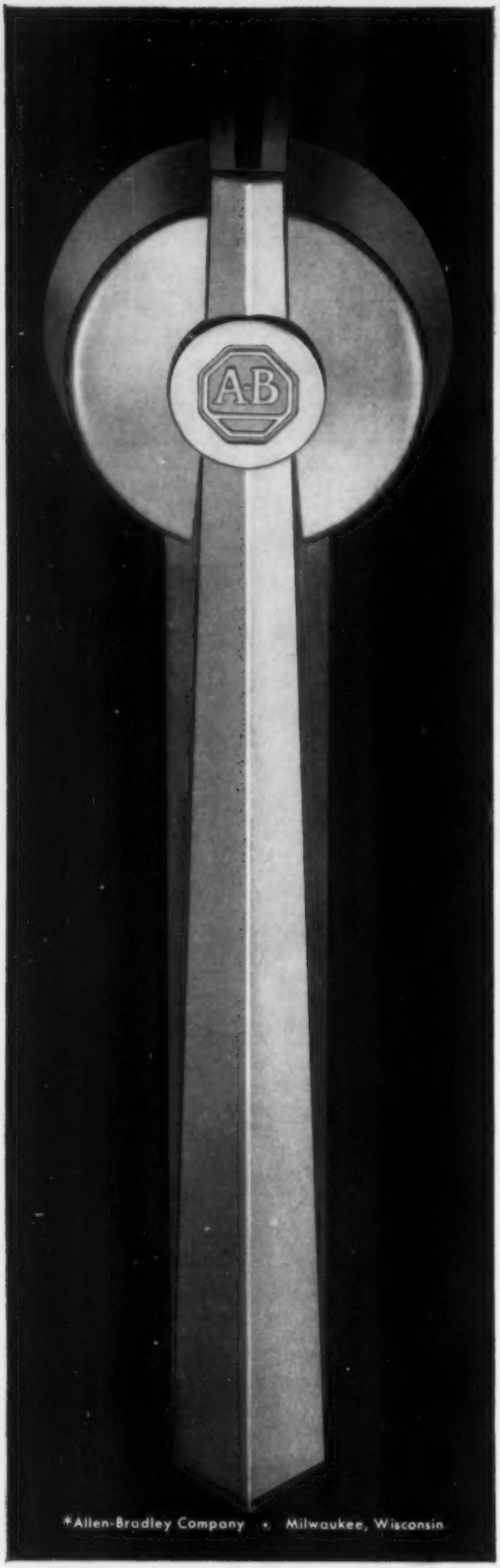
Meanwhile, you may find these Gleason Technical Handbooks helpful in your work:

"20° Straight Bevel Gear System"
"Spiral Bevel Gear System"
"ZEROL Bevel Gear System"

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.



Fundamental Characteristics

emphasized in design details with MADISON-KIPP zinc and aluminum die castings

The carry-through designer permits no unworthy detail to mar his fundamental design effect.

Look at the *AB handle here illustrated. The Kipp die casting faithfully protects the product designer's emphasis on superior quality and last word engineering features.

The attentive mechanics at Madison-Kipp invite you to clip this ad as a reminder to contact them for close cooperation on the momentous details of design, when you next have die casting requirements.

kipp

MADISON-KIPP CORPORATION

206 Waubesa Street • Madison 10, Wisconsin

Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering
Originators of Really High Speed Air Tools

and an open treadle. Base has been extended so switch cannot be tipped by stepping on treadle or treadle guard. May be furnished with a latch for holding treadle in down position. As standard, latch is on right. A down and backward motion of foot makes latch inoperative. One or two contact blocks with snap-action contacts are furnished. Each has normally open and normally closed double break silver contacts. Ac contact ratings are: 6 amp, 110 v; 3 amp, 220 v; 1.5 amp, 440 v; 1.2 amp, 550 v. Dc ratings are: 0.4 amp, 115 v; 0.2 amp, 230 v; 0.1 amp, 550 v. **Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4.**

Circle 35, inside back cover

Rerated NEMA ac motors . . .

are lighter in weight: a standard-frame 1-hp, 1800 rpm, open drip-proof, squirrel-cage motor weighs about 74 lb; rerated motor of same characteristics weighs about 65 lb. Temperature rise remains 40°. High-temperature resistant insulation has been added. Open drip-proof rerated motors are now available. **Brook Motor Corp., 3553 W. Peterson Ave., Chicago 45.**

Circle 36, inside back cover

Indicating-light assortment . . .

is said to answer almost every requirement in 6, 12, 28, 110 and 220-v applications. Packaged in a self-contained mobile unit, electrically powered and lighted, with all tools necessary to mount miniature indicating lights, indicating switches, indicating fuseholders and dial lights. Includes lighted workbench, materials, power and storage spaces. **Alden Products Co., Dept. IDL#89, Brockton 64, Mass.**

Circle 37, inside back cover

Servo system kit . . .

holds 262 standard parts for breadboarding. The 18 x 15 x 10½ in. kit is provided with cutout shelves and individual cartons so that each part can be put back in place when not in use. Gears are mounted so that they will not bump one another or

(Continued on page 136)

THE ALL PLASTIC VALVE THAT
DEFIES CORROSION

VALCOR's all plastic, corrosion-resistant solenoid valve, SV-5100 series, is the only solenoid valve that has no metal contact with the fluid—ever. Specifically designed to handle most of the corrosive media so widely used in industry, VALCOR's new, all plastic solenoid valve will, in many cases, outlast stainless steel valves 100 to 1.

If you have a corrosive media problem, from sulphuric acid solutions to citrus juices, try this new VALCOR valve on your toughest application. Prove for yourself how this new valve defies corrosion. List prices start at $8.50.

IMPORTANT: Hundreds of other valve variations, in design and pressure ratings, are inherent in this new SV-5100 series. By incorporating some of the very newest engineering and chemical formulas, we can offer valve variations designed to meet almost any corrosion problem you might be faced with.

Write today for new catalog sheet. For specific information, please send us pertinent application details.

VALCOR ENGINEERING CORP.
5375 CARNEGIE AVENUE, KENILWORTH, NEW JERSEY

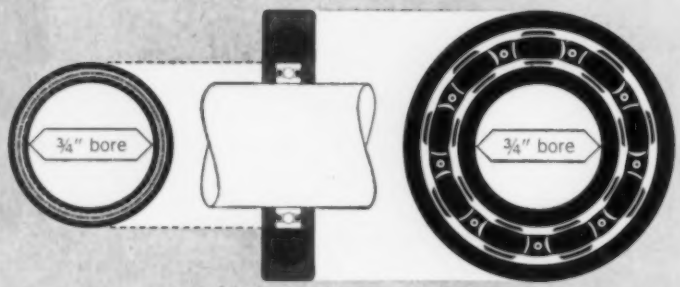
VALCOR
SOLENOID VALVES

how to conquer space

Compact design of instruments and other precision mechanisms calls for critical evaluation of all components in terms of the *space* they require.

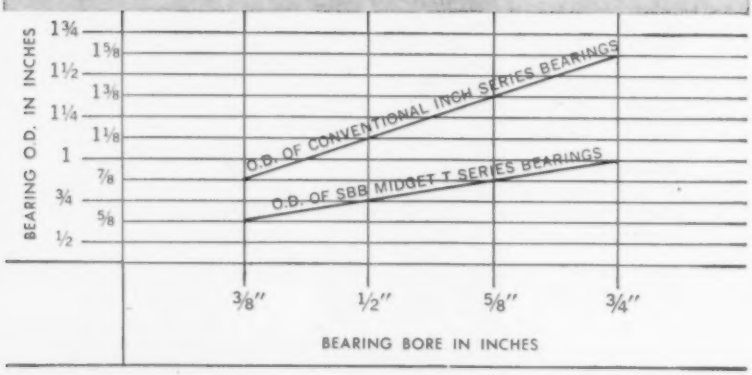
SBB Midget T Series ball bearings can reduce space requirements from 66% to 90% by replacing conventional inch series ball bearings. On basis of ratio of bearing volume to load capacity they are twice as efficient as conventional ball bearings of equivalent bore size. Low torque values, too.

Save up to 46% on O.D. and up to 90% on total volume.



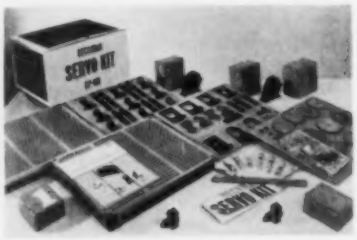
3TCR 12-16 MIDGET T SERIES

CONVENTIONAL BALL BEARING— INCH SERIES



Write today for brochure on Midget T Series.

split ballbearing
A DIVISION OF MPB, INC.
901 HIGHWAY FOUR
LEBANON, N. H.



touch any other part. A checklist identifies each part and tells where to find it. A standard parts catalog contains photos, dimensional drawings and set-up instructions. Available for off-the-shelf delivery. **Helipot Corp., Newport Beach, Calif.**

Circle 38, inside back cover

Plotting sheet . . .

for test data and performance results is reproducible. Single sheet comprises cross-section sketch area, columns to record ordinate and abscissa history, and sections for plot of results. The 8½ x 11-in. pads of 50 rag vellum sheets are $3 each. **Spectrum Design Associates, 1185 State St., Bridgeport, Conn.**

Circle 39, inside back cover

Frequency meter . . .

for panel mounting is a self-contained needle-indicator unit with standard 380 to 420-cps scale readable to accuracies of 0.25% over its entire range. Sensing device is a nonlinear bridge network. At frequencies between 380 and 420 cycles, the bridge provides an output linearly proportional to input frequency. Available in round, square and rectangular versions. **Helipot Corp., Newport Beach, Calif.**

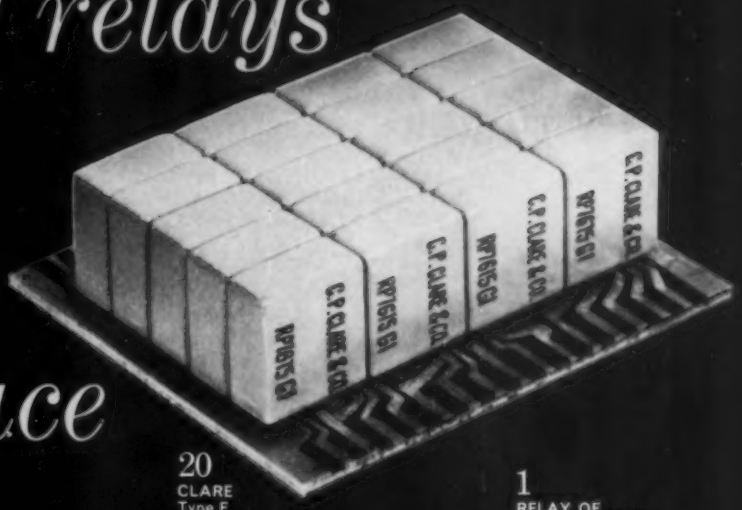
Circle 40, inside back cover

Budget-priced diazo . . .

machines make blue and black line-prints from translucent originals. The 42-in. capacity unit accommodates low-volume print requirements and has fingertip controls that regulate printing speeds up to 4 fpm. Controls also allow for a latitude of background color. With a current inverter, it can be operated from a 12-v vehicle battery for use in field. Price is $287.50. **Blu-Ray, 301 Main St., Ivoryton, Conn.**

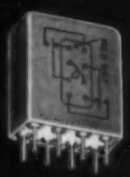
Circle 41, inside back cover

20 times as many relays in 1/3 the space



20
CLARE
Type F
RELAYS
10¼ cu. in.

1
RELAY OF
EARLIER DESIGN
31¼ cu. in.



CLARE *Type* F RELAY

SPECIFICATIONS:

Ambient Temperature	—65° C to +125° C.
Shock	50 Gs for 11 milliseconds.
Vibration	5-75 cps at maximum excursion of ⅛-inch, 75-2000 cps at 20 Gs acceleration.
Dielectric Strength	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 750 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance	1000 megohms minimum at 125° C.
Coils	Coils up to 10,000 ohms available for a wide range of voltages or currents.
Nominal Operating Power	250 milliwatts.
Pickup Time	3.5 milliseconds nominal.
Dropout Time	1.5 milliseconds nominal.
Contact Arrangement	2 pdt (2 form C).
Contact Rating	3 amps resistive at 28 volts d-c or 115 volts a-c; also for low-level applications.
Contact Resistance	0.050 ohm maximum.
Contact Life	500,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps.
Enclosure	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting	All popular mounting arrangements available.
Terminals	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 1/10-inch grid spacing available.
Weight	17 grams.
Military Specifications	MIL-R-25018; MIL-R-5757C, except as to contact overload.

These twenty Clare Type F Modular Relays, mounted on a printed-circuit board, take less than a third of the space occupied by a hermetically sealed relay of earlier design—a relay in wide use a few short years ago.

Clare Type F Modular Relays can be mounted in a closely restricted space—wherever the user desires—on a board punched at 2/10 inch intervals in a grid pattern.

This new hermetically sealed relay—no bigger than a postage stamp—is fast and more than moderately sensitive, yet stalwart enough to withstand extremes of temperature, heavy shock, and severe vibration.

Send for Bulletin 124 today. Write: C.P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C.P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

PROOF that you can

RELY on GI

Fractional H. P. Motors

1/40 H. P. to 1/1100 H. P.

Meet an all-around performance champion. GI's husky, versatile Model "A" motor. Proved dependable millions of times over, it's the power choice of the nation's great-name manufacturers . . . setting an amazing performance record in countless applications from phonographs to kitchen fans to pumps. If dependability is your aim, Model "A" is your motor!

MODEL "A" two-pole shaded pole motor available in various lamination thicknesses. Precision constructed for reliable, long hard usage. Perfectly balanced for smooth, quiet, operation.

Write for quantity price quotations today!

SPECIFICATIONS

MODEL	HP 2800 RPM	Locked Torque In/Oz	Max. Running Torque In/Oz	Rotor Free Speed RPM	A
A-3-CW A-3-CCW	1/500	0.70	1.1	3360	3/8"
A-5-CW A-5-CCW	1/180	1.7	2.7	3430	5/8"
A-6-CW A-6-CCW	1/130	1.9	3.3	3430	3/4"
A-7-CW A-7-CCW	1/100	2.1	3.8	3500	7/8"
A-8-CW A-8-CCW	1/90	2.5	4.5	3480	1"
A-9-CW A-9-CCW	1/70	2.7	5.3	3520	1 1/8"
A-12-CW A-12-CCW	1/60	3.0	6.5	3500	1 1/2"
A-14-CW A-14-CCW	1/50	3.1	7.0	3490	1 3/4"

Standard shaft diameter .1817, 1/4" shaft available if desired.

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 143.

HYDRAULIC EQUIPMENT—Catalog, about 64 pp. Describes product line of pumps, valves, cylinders, motors, hand pumps, power units. With characteristics, specifications, performance data, dimensional information. Indexed for reference. Dynex, Inc., 777 Dynex Drive, Pewaukee, Wis.

Circle 42, inside back cover

MECHANICAL COMPONENTS—Supplemental catalog 15, 24 pp. Information on dimensions, characteristics, applications and price of new ball bearings, bronze bearings, worm and wheel assemblies, helical gear assemblies, magnetic clutches, instrument panel clocks and other components added since issuance of main catalog and supplemental gear list catalog. Pic Design Corp., 477 Atlantic Ave., East Rockaway, N. Y.

Circle 43, inside back cover

POLYURETHANES—Brochures (3). Discuss usage, processes, formulations, physical properties and engineering data on rigid, semirigid and flexible polyurethanes. The material is formed by a mixture of two liquids which then foam and bond with cavity walls. American Latex Products Corp., 3341 W. El Segundo Blvd., Hawthorne, Calif.

Circle 44, inside back cover

RELAYS, SOLENOIDS, SWITCH ASSEMBLIES—Catalog 58, 36 pp. Describes each relay, giving coil and contact specifications, contract combinations, construction and mounting styles of each. With photos and dimensional drawings. Also includes performance curves for solenoids. Comar Electric Co., 3349 Addison St., Chicago 18.

Circle 45, inside back cover

MOLDED, EXTRUDED AND DIE-CUT PARTS—Catalog MME-P, 28 pp. Engineering reference book lists all types, dimensions and durometers of grommets, bumpers, bushings, suction cups, extruded parts, miscellaneous parts. Also lists extrusions and die-cut material meeting government specs. Miller Products Co., Inc., 29 Warren St., New York 7.

Circle 46, inside back cover

ANODIZED STRIP CONDUCTOR—Brochure EE-2-10-158, 12 pp. Discusses advantages, application, heat transfer and joining. Includes an application-data computation chart. Reynolds Metals Co., 2500 S. 3rd St., Louisville, Ky.

Circle 47, inside back cover

ADJUSTABLE SPEED DRIVES—Bulletin GEA-5827A, 8 pp. Discusses industrial applications for adjustable speed drive. Cites benefits, features, standard electrical and performance characteristics. General Electric Co., Schenectady 5, N. Y.

Circle 48, inside back cover

RUBBER AND SYNTHETIC PARTS—Brochure, 6 pp. Illustrates and describes products and facilities for processing. Included is table of properties of natural rubber and most commonly used synthetics. Mechanical Rubber Products Co., 35 Vail Rd., Warwick, N. Y.

Circle 49, inside back cover

SNAP-ACTING SWITCHES—Catalog 0158, 28 pp. Gives information on units in various styles. Pictorial index tells where to find dimensional drawings, descriptions, force and movement spec tables and electrical ratings. Data on bases and terminals, actuator types, circuit arrangements and NEMA sensitive-switch terms are included. Unimax Switch Div., W. L. Maxson Corp., Ives Rd., Wallingford, Conn.

Circle 50, inside back cover

PLASTICS FOR ELECTRONICS—Condensed catalog, 4 pp. Brief descriptions of many of the materials available in microwave absorbers, casting resins, plastic foams, plastic rods and sheets, reflectors and lenses, plastic surface coatings, adhesives, cements and sealants, impregnating and laminating resins. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Circle 51, inside back cover

VIBRATION AND SHOCK MOUNTING SYSTEMS—Bulletin FIA, 4 pp, describes variable-damped aeronautical mounting systems. Discusses design and selection of component parts and problems of vibration-isolation mountings for gyroscopic instruments. Federal Shock Mount Corp., 1060 Washington Ave., New York 56.

Circle 52, inside back cover

STRUCTURAL SANDWICH — Brochure, 4 pp. Fabrication, connections,

(Continued on page 140)

A new dimension in flexibility!

You get *up to 70°* usable working angle (or equivalent shaft offset) with *two* Rzeppa Constant Velocity Universal Joints connected for double-action flexibility.

Rzeppa (pronounced "Sheppa") Joints, used singly or in combination, give 100% smooth torque with the strength and capacity required by heavy-duty coupling and drive-line applications. And every Constant Velocity Universal Joint is built for a long life of trouble-free service.

Call or write today for performance and engineering facts on the complete line of Rzeppa Constant Velocity Joints for every aircraft, marine, vehicular and industrial speed.

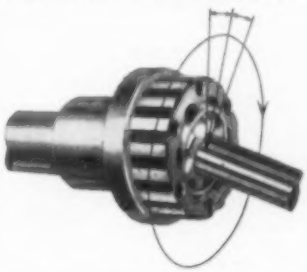
RZEPPA "SHEPPA" *Constant Velocity Universal Joints*

58RJ-1

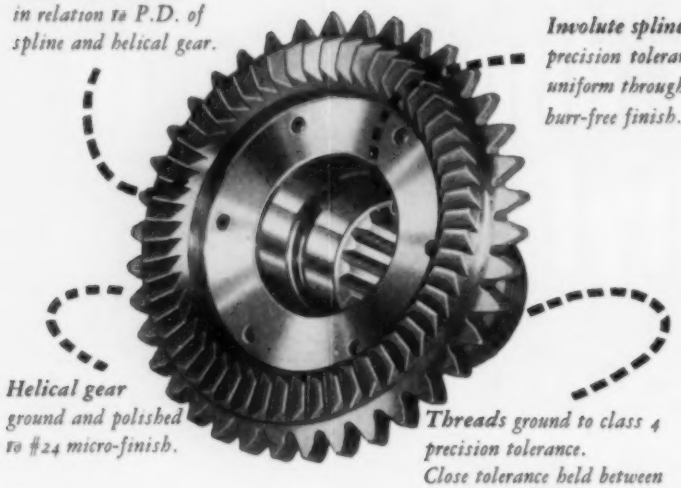
THE GEAR GRINDING MACHINE CO., 3939 CHRISTOPHER, DETROIT 11, MICHIGAN • MANUFACTURERS OF: FULLY AUTOMATIC GEAR GRINDING MACHINES, DETROIT SCREWMATIC 750 SINGLE SPINDLE SCREW MACHINES

Plus RZEPPA'S smooth money-saving action

Old-fashioned pin or slipper-type joints speed up and slow down twice during one revolution, must use precision alignment techniques to compensate for "rock and roll" action at extreme angles.



Rzeppa Joints operate without chatter or bounce. Ball bearings deliver smooth rotation, reduce friction for longer joint and shaft life.


Generated clutch held at close tolerance in relation to P.D. of spline and helical gear.
Involute spline, precision tolerance, uniform throughout, burr-free finish.
Helical gear ground and polished to #24 micro-finish.
Threads ground to class 4 precision tolerance. Close tolerance held between thread and P.D. of helical gear.

DON'T GAMBLE WITH GEAR PERFORMANCE

YOU know that gambling with gears can cost you money — production delays, costly rejects, failures in use. You don't want to take chances with your customers . . . they expect day-in, day-out performance from your machines. Your performance guarantee can be Perkins custom-cut gears . . . precision gears made to your exact specifications. Perkins' 52 years of gear-making know-how, extensive facilities and equipment, and rigid production controls assure uniform tolerances throughout . . *.plus* a consistent micro finish. You get perfect meshing and full capacity from every gear. Many leading manufacturers — Sikorsky, Stanley, Universal Winding, for example — rely on Perkins for top-quality gears, gears that cost less in the long run. Ask us to quote on your next gear requirement. Then judge for yourself.

YOURS ON REQUEST Folder illustrating gears Perkins has made — face gears, generated and curvic clutches; bevel, spiral, helical and spur gears; ratchets, sprockets and ground thread worms — from all materials. Includes Perkins facilities for producing various gear types and sizes. *Write today.*

PERKINS
MACHINE AND GEAR CO.

Dept.22,West Springfield, Mass.
Telephone: REpublic 7-4751

inspection, assembly and efficiency of the sandwich are described. Zahorski Engineering, Inc., 133 E. Canon Perdido St., Santa Barbara, Calif.

Circle 53, inside back cover

ELECTRICAL COMPONENTS – Catalog, 26 pp. Describes and illustrates specialized valves, solenoids and switches. Gives specs and dimensional drawings for each of 13 components. Koontz-Wagner Electric Co., Inc., South Bend, Ind.

Circle 54, inside back cover

OSCILLOGRAHIC RECORDING EQUIPMENT–Catalog, 16 pp. Contains descriptions, specs and prices of Series-150 recording stems and accessories, and unit instruments. Illustrated with schematics and photos. Sanborn Co., Industrial Div., 175 Wyman St., Waltham 54, Mass.

Circle 55, inside back cover

ELECTROMETER-MEGOHMMETER –Bulletin 1, 4 pp. Includes description, photos, schematics, technical specs and price of the instrument. Walter N. Trump, 516 S. Vermont Ave., Columbus, Kans.

Circle 56, inside back cover

CHROMIUM-ALLOY COATING–Brochure, 24 pp. Defines the process of depositing a hard, dense, nonmagnetic alloy on the surface of the base metal to increase wear and corrosion-resistance. Gives test data and discusses case histories. Electrolizing Corp., 1505 East End Ave., Chicago Heights 5.

Circle 57, inside back cover

ALL-PURPOSE EPOXY CASTING RESIN–Bulletin RPD 300, 4 pp. Describes and explains features of new resin. With details of physical properties, hardness and thickness charts and prices. Rezolin, Inc., 1651 18th St., Santa Monica, Calif.

Circle 58, inside back cover

PLASTIC ROD AND TUBES–Circular, 2 pp. Describes sizes and shapes of extrusion moldings currently in stock. Also, applications of extrusion molding in industry. Ace Plastics Co., 91-30 Van Wyck Expressway, Jamaica 35, N. Y.

Circle 59, inside back cover

THERMISTOR-PROBE ASSEMBLIES –Brochure EM-13, 4 pp. Nine assemblies are described and each is identified by its most common application. With dimensions and mounting arrangements. Fenwal Electronics, Inc., Mellen St., Framingham, Mass.

Circle 60, inside back cover

DIESEL ENGINES – Catalog BU-413, 16 pp. Two new engines are described

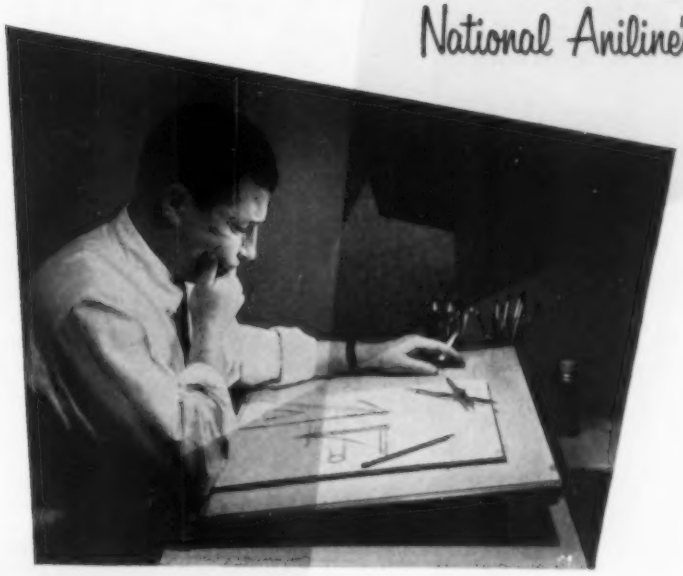
(Continued on page 143)

when only a "tailor-made" material will do...

URETHANES!

based on

National Aniline's Nacconates®



Foams—Flexible to rigid. Open or closed cells. Densities from one to 30 lbs/cu. ft. or more!

Cushioning—For comfort *or* shock absorption and vibration isolation! Resilience controllable from "dead" to full of "life"!

Durability — Excellent mechanical properties and resistance to aging, chemicals, cleaning and mildew!

Insulation—Thermal . . . acoustical . . . or electrical. Outstanding for all three!

Elastomers—They're resilient as rubber and wear like steel!

Never before a material like it!

You prescribe the properties you need. Urethanes are more likely to give you exactly what you want . . . better, faster, easier and more economically . . . than the material you are now using. Some of the amazing possibilities are shown here!

YOU SAVE PRODUCTION COSTS, TOO!

Urethanes start closer to your finished product, eliminate many production steps. They can be molded to required shapes, foamed in place to fill voids. They adhere to other materials or encapsulate difficult shapes. They can be used in strong but lightweight sandwich construction, sprayed to adhere even to vertical or overhead surfaces. Slab stock can be sliced, die-cut, sewn, tacked or hog-ringed.

INFORMATION FOR PROSPECTIVE USERS

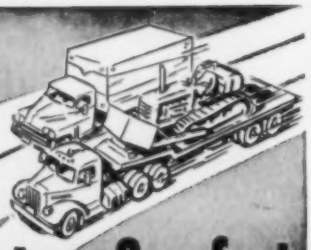
As makers of NACCONATE® Diisocyanates, basic urethane chemicals, we have gathered considerable application data. We will be glad to furnish pertinent information if you will write on your company letterhead briefly describing your particular interest.

Allied Chemical

NATIONAL ANILINE DIVISION ALLIED CHEMICAL CORPORATION • 40 RECTOR STREET, NEW YORK 6, N. Y.

Akron Atlanta Boston Charlotte Chattanooga Chicago Greensboro Los Angeles New Orleans Philadelphia Portland, Ore. Providence San Francisco Toronto

TRUCKS
"SEMI'S"
ROAD
MACHINERY



Here's Contour Comfort Never Before Equalled

MILSCO

ROAD KING

Contour CUSHION SEAT

- FULL DEPTH FOAM RUBBER
- IDEAL VENTILATION
- STURDY STEEL BASE
- WITH OR WITHOUT RISER

Milsco
MILWAUKEE

The Milsco ROAD KING Contour Seat is the result of many hours of engineering and styling, many thousands of miles of severe road testing. It is undoubtedly the most comfortable contour seat available anywhere. The ROAD KING is padded with extra-thick, extra live foam rubber with a choice of coverings: Elastic Naugahyde, Silver Koroseal, or Genuine Flexible Cowhide.

where your seating dollar goes further

MILSCO MFG. CO. • 2756 N. 33rd ST. • Milwaukee, Wis.

if you have a bearing problem,

here is your answer...

You can solve your bearing problems in the research and development stages or on the assembly line by specifying custom-fabricated Flexible Bearings by Bushings, Inc.

For when you design Flexible Bearings by Bushings, Inc. IN as original equipment you design noise, shaft-wear, vibration, shock and misalignment OUT.

Flexible Bearings by Bushings, Inc. have a mechanical bond between the flexing medium and the inner and outer members. They are available in two types: TORSIONAL for oscillating movement; PROTECTIVE for insulating solid bearings against load, sudden shock, misalignment and noise transmission.

Flexible Bearings by Bushings, Inc. are custom-fabricated to YOUR specifications—to do the job you want done.

So, for fast, authoritative engineering help on your bearing problems or needs—on the production line or the drafting board—write Harvey G. Moore at the address below.

For more than 15 years Bushings, Inc. has custom-fabricated bearings in a wide range of metals and sizes for hundreds of different manufacturers.

VIBRO-LEVELER MOUNTS dampen vibration, permit precision leveling of machines.

SILENT LIGN PILLOW BLOCKS for shaft mounting. Has all Flexible Bearing features.

Bushings, Inc.

4358 COOLIDGE HIGHWAY • ROYAL OAK, MICHIGAN

with photos, cutaways, charts and other illustrations. Explains operating and performance advantages of the engines. Allis-Chalmers Mfg. Co., Milwaukee 1.

Circle 61, inside back cover

STABILIZED CERAMICS – Bulletin 686 NP 1, 8 pp. Describes physical properties of nitride-bonded, recrystallized or self-bonded ceramics resistant to thermal shock, extreme temperatures, highly reactive materials. Norton Co., Worcester 6, Mass.

Circle 62, inside back cover

CUSHIONING CORK–Bulletin VC-501, 2 pp. Discusses characteristics and performance of a vibration, shock and noise-controlling material. Properties are shown in drawings, curves and charts. Korfund Co., Inc., 48-19C 32nd Pl., Long Island City 1, N. Y.

Circle 63, inside back cover

SPEED REDUCERS, GEARS–Catalog, 180 pp. Details of speed reducers, custom and commercial gears are given. Sizes, ranges, capacities and types available, as well as illustrations, schematic drawings and specs are included. Grant Gear Works, Inc., 154 W. Second St., Boston 27.

Circle 64, inside back cover

TAPE CONTROL SYSTEMS–Brochure, 12 pp, describes machine-tool control systems from drawing stage to control tape and control unit. Explains how control tape is prepared and how machine-control unit uses tape information. A typical machine is discussed and three case histories are given. Bendix Aviation Corp., 21820 Wyoming Ave., Oak Park, Mich.

Circle 65, inside back cover

CASTING PATTERN DESIGN–Product Data Sheet 2, 2 pp, gives information on relation of standard casting practices to pattern and casting design. Production factors such as metal shrinkage and minimum section thickness when designing patterns and castings are stressed. Alloy Steel Casting Co., 102 County Line Rd., Southampton, Penna.

Circle 66, inside back cover

Letterhead Requests Only

Mnaufacturers who published following literature ask that requests for copies be made on company letterheads.

HYDRAULIC LINE TUBING–Brochure, 10 pp. Explains construction, manufacture, features, and provides list of specifications. Includes table of recommended working pressures and size ranges. Republic Steel Corp., Steel & Tubes Div., 224 E. 131 St., Cleveland 8.

REEVES *Vari-Speed MOTOR PULLEY*

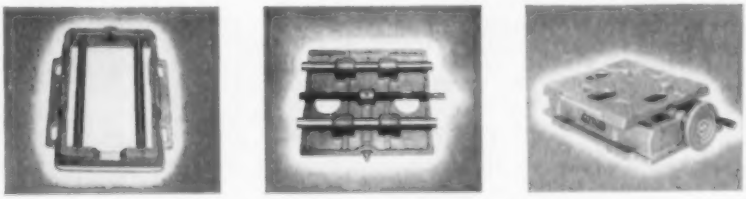
Here is variable speed control in its most simplified form . . . variable speed control with new economy.

Disc assemblies have just three main parts: two smooth-face, cone-shaped discs; and the belt tension spring. There are no other wearing parts to give maintenance trouble. Compact disc assemblies available in nine sizes, ½ hp. through 15 hp., to fit both old and new NEMA motors.

Separately mounted countershaft assemblies are available. For complete information on sizes and available controls, write for Bulletin K36-V582.

Split section view of sliding disc shows how REEVES "close grooving" maintains film of lubricant between hub length of fixed disc and bore of sliding disc. One lubrication point services entire disc assembly.

New precision bases Four compact sizes to accommodate old and new NEMA motors in ½ through 15 hp. Sturdy bases are specially manufactured to assure positive, easy adjustment and accurate speed control.



Base and motor slide rods manufactured for precision fit and true alignment. Fully-lubricated shifting screw and precision features provide easy shifting.

REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

NEW BULK PACKING FOR SOUTHERN SCREWS ...designed for you!

DESIGNED FOR MODERN MATERIALS MOVEMENT, FITS ALL PRODUCTION LINES, WHETHER LARGE OR SMALL

Southern Screw's new bulk packing answers your long-time need for a conveniently sized industrial package that can be handled easily by one man without the use of power equipment, yet is ideal for mechanized mass handling with or without palletizing.

Here's how Southern's NEW BULK PACKAGE can save you handling time, production time, storage space and paperwork.

EASIER TO STORE • EASIER TO OPEN and CLOSE • EASIER TO USE • EASIER TO IDENTIFY • HEAVY DUTY CORRUGATED CARTONS • DISPOSABLE PALLETS AT NO EXTRA COST!

Based on the new pallet and carton system, standard packing quantities for each item have been established. For complete information, write for chart BP-1, to Southern Screw Company, Box 1360, Statesville, N. C.

Wood Screws • Stove Bolts • Machine Screws & Nuts • A, B, C & F Tapping Screws • Wood Drive Screws •

Warehouses: New York - Chicago - Dallas - Los Angeles

Southern SCREW COMPANY
STATESVILLE • NORTH CAROLINA

tangents...

The Reason Why

Secrecy is, we suppose, a good thing, but it can easily be carried too far (PE–Dec. 16 '57, p. 24; Mar. 31 '58, p. 102; Apr. 14 '58, p 52. For 30 years, we have fulminated over company secrecy–the business of hiding processes or ideas under a bushel (so only competitors know about them). But, in the past ten years, the same technique has been applied to our national developments.

We agreed with the policy eventually developed of telling the public what Washington was sure the USSR already knew. It wasn't an ideal policy –sometimes excellent chances to get credit for a real contribution were muffed–but it was a workable one.

Somewhere along the line, however, the idea was warped into the old concept of withholding news for "policy" reasons–in other words, because some high brass decides it's too heady for the people. One result was the national uproar over Sputnik I.

You'd think that this experience would have taught its lesson. It didn't; the abuses are still going on: the British success at controlled fusion, our atomic showdown, even the abortive flight of Explorer II, on which the facts were held up for no earthly reason. Seemingly, the Army is now as loath to admit defeat as the Navy.

In that particular case, for several days we were fed hopes that the "moon" was orbiting. The scientists missed–or were prevented from–telling the facts that would have given laymen an idea of what they are doing. Scientists guessed Explorer II's fate in a half hour, were sure in three or four hours. They'd have known sooner, except that the fourth stage was so filled with scientific equipment that there wasn't room for a signaling unit, a radio, to give the facts.

Even so, the Doppler trackers indicated three drops in pitch to show three stages had fired–but no fourth. The Cape Canaveral instruments could be wrong, however, so scientists waited for the time the satellite was due to cross Earthquake Valley, Calif. No signal. So they waited the time of another circuit. No signal, and besides Fort Monmouth had confirmed the lack of the fourth drop in Doppler tone. The fourth stage had not fired, so Explorer II never got over 11,000 mph.

That was the time to say so. Why didn't the Army set the Navy an example and admit failure?

Or again, consider the case of the breakup of Sputnik I. Dr. John D. Case of Ohio State operates a radio telescope with which he can track pea-sized meteors. He reasoned that he could also track Sputnik I. He did, after its radio was dead and nobody seemed to be sure where it was. He gave credit to two other scientists, Prof. Lloyd R. Wylie and H. T. Castillo of the Physics Dept. at Wittenberg College, Springfield, Ohio. They had noticed that meteors could be tracked simply by tuning in to the 20-megacycle broadcast band of WWV, the National Bureau of Standards station in Washington. During the day, the sunlight makes the ionosphere (which is really a blanket of dust from meteors) into a close-knit pattern, so WWA signals are bounced back for clear hearing in Ohio. But at night, the ionosphere thins, so the signals don't bounce–unless a meteor enters and leaves behind it a thin ion strip or trail that reflects the beeps to Ohio as if it were day.

Anyway, Kraus got bursts of beeps from Sputnik I's trail three minutes long, indicating a 900-mile path. Kraus recorded path after path, thus got a pattern so he knew how long the satellite took per circuit and how rapidly it was approaching the earth.

By the night of Jan. 4, the "moon" was only 100 miles over the earth. Suddenly the signal path split into three parts–the satellite was breaking up. By the next night, two of these three pieces were breaking up, and by Jan. 6 there were eight fragments. One disappeared the next night, three on Jan. 8, three Jan. 9, and the final one Jan. 10. Any parts of Sputnik I were thereafter dust too fine to detect. The "moon" that was expected to die in a burst of glory simply came apart instead. As Dr. Kraus has said, there may be some of it in the raindrops that hit you.

Why wasn't this story, certainly as

(Continued on page 147)

Precision Rings with little or no machining

Today you can purchase precision flash butt-welded rings that require little or no machining to meet your specifications. Made from bar stock of finished gauge, they can be produced to meet the same tolerances as conventionally machined rings. Cost of production and materials of some rings has been reduced as much as 60%. Sizes and materials at present are limited to those bar stocks which can be furnished to precise finished dimensions. However, persistent efforts of American Welding engineers and the producers of finished bars give promise of a widening range of sizes and metals that can be manufactured by precision forming and welding.

This is another example of why you should call American Welding first — if the problem is circular and of metal.

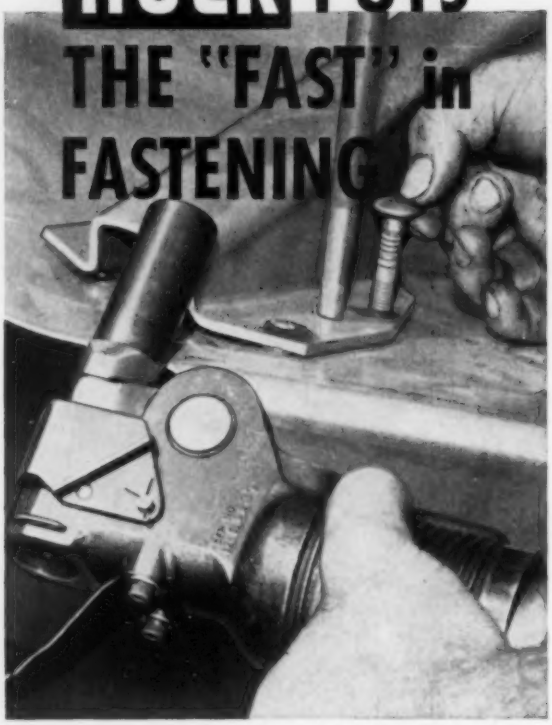
New Products Catalog

Write today for 20-page catalog of circular products which American Welding can form, weld and machine for you.

AMERICAN WELDING

THE AMERICAN WELDING & MANUFACTURING CO.
140 DIETZ ROAD • WARREN, OHIO

HUCK PUTS THE "FAST" in FASTENING



Whether you are interested in fasteners that will hold permanently "fast" or are "fast" to install, HUCK gives you both.

Nowhere can you find so many desirable features as you'll get with HUCK FASTeners.

POSITIVE MECHANICAL LOCK—can't slip, strip or wear loose.

UNIFORM INSTALLATION—Every fastener identically tight, automatically "torqued" by the installing tool.

TIME SAVING—Easily installed by unskilled labor up to ten times faster than ordinary fasteners.

NO BUCKING—Whether headed or blind type, the tool "pulls" fastener tight from work side.

NO WORK DAMAGE—Tool never touches work, can't dent, gouge or scratch the product.

EASILY REMOVED—Simple tools afford fast removal without damage to product.

ECONOMICAL—Installed cost is below most ordinary fasteners.

Huck fasteners are made in many types, sizes and materials. A Huck fastening specialist will gladly point out the one best suited for your needs and demonstrate their advantages on your product in your own plant. We invite your inquiry.

HUCK *MANUFACTURING COMPANY*

2480 BELLEVUE AVENUE • DETROIT 7, MICHIGAN • Phone WA. 1-6207

12 REASONS WHY...

Bendix Electric Fuel Pump performs better . . . lasts longer!*

1. Performance-proven
2. Longer Life • No Pressure "Droop"
3. Dependable Operation at −75°F.
4. Improves Low-Temperature Starting
5. Built-in Pressure Release
6. Eliminates Vapor Lock
7. More Gallons per Hour
8. Easy to Install and Service
9. Low Power Requirements
10. Economical Operation
11. Light Weight • Compact
12. Rugged • Tamper-proof

Learn more about this new and improved fuel pump. Write for descriptive folder and specifications.

ECLIPSE MACHINE DIVISION **ELMIRA** N. Y. **Bendix** AVIATION CORPORATION

*REG. U. S. PAT. OFF.

New **Engineering Handbook on**

TEFLON*

Fully describes its advanced usage as a cushioning and insulating material for wire and tube supporting clamps.

Send now for your copy of this new 20-page illustrated "TX" Engineering Handbook on Teflon* (Tetrafluoroethylene). Contains all latest information on Teflon* including chemical, thermal, electrical and aging properties as well as modern methods of handling it. Illustrates seven models of Teflon* cushioned support clamps which are available in 18 standard types. Included is a comprehensive tabulated chart covering 28 tests, furnished courtesy of the Du Pont Company. Write today for free copy.

**Du Pont Company registered trademark.*

TA MFG. CORP.

4607 ALGER STREET • LOS ANGELES 39, CALIFORNIA

dramatic as most of the others about the satellites, told in detail? It remained for John Lear, Science editor of *The Saturday Review*, to tell three months later in his column of April 5.

This seems to be bad reporting by the news services, as the earlier story on Explorer was bad publicity by the Army. What's become of our vaunted ability to get the news? We'd better recover it, and at the same time forget the arbitrary divisions of time that schedule occurrences to fit budget crises in Congress, the latest propaganda "line," TV news programs, or newspaper and magazine editions. And we must forget the distortions of truth that have been plaguing us.

Here are some examples of Pentagon distortion: Successful Soviet firing of an ICBM, called "unimportant," "untrue," and "idle boast." Firing of Sputnik I, which brought the same comments. Publicizing of a nose cone that "solved the re-entry problem"—which actualy re-entered at less than the speed required for an operational missile (Mach 14 instead of Mach 21). Decision to produce the *Snark*, so slow it can be brought down by a bomber. The B-52, "standard in our Strategic Air Command" is really "standard" in only four of 45 wings. The atomic explosion underground was reported as something that could be kept secret, apparently to discredit efforts at abandonment of such tests. Secretary Wilson reported Soviet cutback on *Bison* bombers to justify cutbacks on the B-52, but didn't mention Soviet successes with the ICBM as the real reason.

These cases are all reported by Thomas Braden, publisher of the Oceanside (Calif.) *Daily Blade-Tribune*, in "Why My Newspaper Lied," in *The Saturday Review* for April 5. It will bear reading by anyone. His conclusion is likewise worth remembering—and doing something about. It is: "It would be well for Americans to bear in mind that the battle of the press to get the whole truth is their battle, and that the people own the right to know. Government officials have to be reminded, from time to time, that they are granting no favors when they show the facts; they are doing what they are put there to do."

If we are so excitable we must be fed pap instead of meat, it's time we found out. —EJT

BRUNING-IZED FINISH DOUBLES SEAL LIFE

YOU KNOW WHY the moment you take a piston's-eye view down the bore of a Bruning "DECCTO" cylinder. Our exclusive BRUNING-IZED mirror black bores increase seal life tremendously, and—the "DECCTO" saves you space, weight and cost in any application.

Specified as "Standard Original Equipment" on thousands of applications ranging from hypersensitive missile control systems to heavy duty industrial, automotive and military ordnance installations—"DECCTO" is consistently and effectively replacing cylinders weighing two to three times as much and costing two to five times as much.

Bore diameters 1½" to 4"—3000 psi working pressure—burst pressures to 10,500 psi.

COMPETITIVELY PRICED...WITH FAST DELIVERY!

DECCTO

for specifications, prices, test samples...contact—

the *Bruning* COMPANY

P. O. BOX 147 LINCOLN NEBRASKA

LOOK TO BRUNING, also, for

QUICK DISCONNECT COUPLERS for industrial, agricultural, aircraft and missile applications . . . FUEL SYSTEM COMPONENTS for Aircraft and Missiles . . . plus DESIGN, DEVELOPMENT, and MANUFACTURE of CUSTOMER SPECIALS

GET FULL DETAILS TODAY . . . write

the BRUNING COMPANY P.O. Box 147 Lincoln, Nebr.

Send me information _____

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

At Last!

a NEW, more efficient pneumatic pressure regulator that...

- Eliminates cranking
- Has greater operational range...50 to 4500 psig
- Completely safe...accurate
- Adaptable to wider range of gas control requirements

A major step forward has been achieved by Marotta with the NEW RV-23 Pressure Regulator. By employing completely new design concepts, set pressures are reached quickly, effortlessly...held accurately...vented safely...over a wider range than any single or series of existing regulators.

Now available for hand regulation of gases as required in testing and calibrating units. For use as integral part in gas systems—can be operated automatically, by remote control, or on a "programing" sequence.

SPECIFICATIONS

Models: Regulator—¼" dome loaded pneumatic pressure reducer. Hand type or remote control type 24 V.D.C. Solenoid operated

Pressure Characteristics Inlet, outlet, and gage ports per MS33656-4

Inlet pressure range—250 to 4500 psig
proof pressure—6750 psig
burst pressure—11,500 psig

Outlet pressure range—50 to 4000 psig
proof pressure—6700 psig
burst pressure—10,000 psig

Rated Capacity 0.1 (SCFM/PSIA) min. (as defined in MIL-R-8572-A)

PRV-11A Special 6" 160 psi LOX Pressure relief

MV-74-H ¼" three-way 6000 psi General Purpose Solenoid

MV-41A ⅛" N.C. 1000 psi Fuel Solenoid

RV-4 ⅜" 60 psi Integral Relief Pressure Regulator

MV-36 ½" N.C. 3500 psi Internally Piloted Solenoid

write or call for complete information
graduate engineers available for consultation

Marotta VALVE CORPORATION

pioneer producers of high pressure valves

P.O. BOX 330-H BOONTON, N. J.

Important News FROM MEYERCORD

CHECK AND PIN THIS AD TO YOUR LETTERHEAD AND WE'LL SUPPLY THE FACTS

PLANT MAINTENANCE MARKING KIT

for Marking Water, Heating and Air Conditioning Systems

The modern, low cost solution to plant equipment identification . . . now in use by leading manufacturers and service organizations. Provides standardized identification, absolute legibility, and permanency at remarkably low cost. Kit includes 474 signs assorted over 59 operational subjects. Easily applied in seconds. Check for literature.

LUBRI-CAL MARKING KIT

Take the Guesswork Out of Your Lubrication

An important preventive maintenance program. The *Lubri-Cal Marking Kit* consists of the proper frequency of numerals, letters and instruction nameplates for identifying lubrication points and required lubricants on plant, production and operating equipment. *Lubri-Cals* are permanent, tough, oil-resistant transfers; easily adaptable to any lubrication system.

MEYERCORD DECAL MARKING METHOD

Decal product markings for "difficult surfaces"

Heat, abrasion, weather and many of the new industrial surfaces are deadly enemies of most product markings. But not to new, improved Meyercord Decal Markings—types C, G, J and H (heat resistant). One of these new markings will almost certainly solve the problem. For exact recommendations ask for new brochure.

the MEYERCORD co.
Dept. U-318, 5323 West Lake St., Chicago 44, Illinois

---

new 6"x3"

WAGNER HYDRAULIC BRAKE SYSTEM

Provides sure stops for smaller cranes

Wagner now offers a new 6" x 3" size hydraulic brake to provide the correct braking system for floor operated pendant controlled cranes, monorail cranes or small cab operated cranes. These hydraulic brakes will stop your cranes safely . . . easily . . . economically.

Let your nearby Wagner Sales Engineer help you put the *right* braking system on your small or large cranes—let him help you with tension control or hydraulic actuating problems—call him today, or write for Wagner Bulletin IU-226.

W158-3

Wagner Electric Corporation
6406 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.

DESIGN ABSTRACTS

Joining Plastics Parts

Four methods (blind riveting, press fitting, induction welding, spin welding) of joining plastics parts are described and design considerations discussed. Resulting strengths, tolerance limits, equipment and power requirements and applications are all included.

Abstracted from "Methods for Joining Plastics Parts", by A. J. Cheney and W. E. Ebeling, E. I. du Pont de Nemours & Co., Inc., SPE Journal, Mar. 1958, Security Bank Bldg., Athens, Ohio.

Communication and Guidance in Space

The need for guidance in space-travelling vehicles is indicated by unavoidable inaccuracies in launching, imperfections in the rocket, and conditions prevailing at time of launching. The three applicable types of guidance systems (command, inertial, star-tracking) are discussed and their functions described. How requirements for trips to the moon and those to the planets must differ are pointed out. Spaceship control systems are compared.

Abstracted from "Interspace Communication and Guidance", by W. M. Borman, Armour Research Foundation, Illinois Institute of Technology, Chicago 16.

Coatings for Metals in Temperatures to 2400 F

Coatings are now available which provide: 1) alloys low on strategic-materials index with high alloy corrosion and oxidation resistance; 2) usefulness for metals at higher than recommended temperatures; 3) longer service life in extreme conditions. Among the coatings discussed are: zirconia, alumina, nickel-magnesium oxide, rutile, alcermet.

Abstracted from "Corrosion- and Oxidation-resistant Coatings for Metals for Operation at Temperatures from 1000 to 2400 F," by J. V. Long, Solar Aircraft Co., SAE paper 46 C, 48 Lexington Ave., New York 17.

Polycarbonate Resin

Characteristics, properties, applications, advantages and disadvantages, processing and fabricating considerations are discussed for this tough, heat-resistant, dimensionally stable group of thermoplastics. Impact strength of this new material is over 12 ft-lb/in. of notch, heat-distortion point is 280-290 F; resists thermal-oxidative degradation up to 300 F. Can be injection molded or extruded.

Abstracted from "Polycarbonate Resin", by R. J. Thompson and K. B. Goldblum, General Electric Co.; Modern Plastics, April 1958, 575 Madison Ave., New York 22.

Electro-hydraulic Control Systems

Development, design, production of these systems are discussed, with detailed attention to electrical, hydraulic, gaging, and systems engineering. Results of combining electrical, electronic, optical, pneumatic and hydraulic devices and techniques are described. Experiences with an analog computer in developing these systems are recounted. A number of case histories are described. Building-block component design is evaluated.

Abstracted from "Electro-Hydraulic Control Systems," by E. J. Rivoira, H. M. Fuldner, O. L. Baily, Cincinnati Milling Machine Co., Cincinnati 9.

Humanities in Engineering Curricula

The article is by a humanities teacher who states that engineering students should study cultural subjects solely to enrich their lives, and only then will such studies help them become better engineers.

Abstracted from "A Humanities Teacher Looks at Engineering Education," by T. F. Green, Basic College, Michigan State University; Journal of Engineering Education, March 1958, University of Illinois, Urbana, Ill.

"I appreciate getting the practical side of our problem, Johnson, however—"

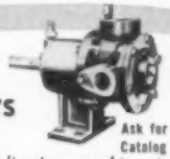
SMALL SIZE
VIKING PUMPS
Built to Meet Your Needs

. . . FOR PRESSURE LUBRICATION
⅓ to 3½ G.P.M.

Ask for Catalog BX

Small pumps available in mounting arrangements to fit your equipment — stripped models or standard construction. Suitable for pressures to 500 PSI, handling lubricating oils. Packing or mechanical seal.

. . . FOR COOLANTS
5 to 35 G.P.M.



Ask for Catalog JX

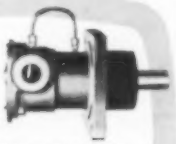
Pumps for delivering machine tool coolants in smooth, positive flow. Handy port location — just turn casing in bracket to fit your piping. Relief rotor eliminates need for bypass equipment.

. . . FOR LIQUID TRANSFER
5 to 18 G.P.M.

Ask for Catalog BX

For smooth transfer of any clean liquid — thin to thick. Available in any mounting arrangement. Pump available in cast iron, steel fitted, bronze fitted, all bronze, stainless steel and many other materials. Packing or mechanical seals.

. . . FOR HYDRAULIC APPLICATIONS
5 to 200 G.P.M.



Ask for Catalog IX

Suitable for pressures up to 500 PSI on hydraulic oils, intermittent service . . . 250 PSI on continuous service. Bracket mounting permits turning pump to fit your equipment.

VIKING — the leader, not a follower, in Rotary Pumps

VIKING
Pump Company
Cedar Falls, Iowa
In Canada, it's "ROTO-KING" pumps

See Our Catalog in Sweet's Product Design File

put your finger on PROFIT

This magnified minuscule electrical part is another Advance Stamping which saved production costs.

Yes—*bigger profits* from *smaller parts* are very possible when you engineer in Stampings—especially *Advance Stampings.* As Specialists in Small Stampings, Advance has been helping metal working industries of various kinds attain higher production at lower cost for over 35 years.

Here are typical Advance Stampings which have been fabricated in different materials to meet tolerance specifications, delivery and price.

Send us your blue prints or samples for quotations. Advance engineers are available to consult on ways to improve your competitive position.

Write for Small Stamping Specialists Brochure

ADVANCE STAMPING CO.

12029 Dixie Ave., Detroit 39, Michigan

Does this

PROCTOR INFINITE WATTAGE CONTROL

have a place in your product?

This Proctor bimetallic control offers... accurate, yet inexpensive control of average wattage input... new circuit simplicity . . . ease of calibration . . . full control between 6 and 100% of rating... voltage compensation at all settings except "FULL"... double line break at the "OFF" position.

A bimetal, heated by the load current, cycles between "make" and "break." The length of the "make" is controlled by positioning a figured cam. Contact action is clean without either "creep" or "snap." This is the exclusive Proctor design that makes high capacities possible.

- **These Proctor controls are small and easily installed.**
- **They have a minimum of operating parts and electrical connections.**
- **There are no motor driven cams or sliding contacts.**
- **Life tests up to ¼ million cycles show negligible contact wear.**
- **236 volt A.C. models are available up to 3000 watts.**
- **118 volt A.C. models are available up to 1500 watts.**

FREE! Ask for bulletin No. G-57A, giving complete details of the Proctor Infinite Wattage Control. Write or phone for your copy today.

PROCTOR

Equipment Division

PROCTOR ELECTRIC COMPANY

3rd Street and Hunting Park Avenue, Philadelphia 40, Pa.

NEW BOOKS

Work Simplification

GERALD NADLER, *Professor of Industrial Engineering Washington U., St. Louis, Mo. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 6x9, 292 pp. $6.50.*

A practical book for application of the principles and techniques of work simplification. The book explains the techniques of this work-saving process and how they are used; very little information is given about why the techniques work, or about the background and development of the concepts.

The book tells how to analyze and improve manual work methods to increase productivity, reduce fatigue, eliminate danger, and save materials. It clearly describes the techniques, illustrating their application to different types of work with many examples. The book will be useful to all concerned with effort and efficiency in work, whether in a factory, store, office, hospital, or home.

Basic Motion Timestudy

GERALD B. BAILEY, *Director, and* RALPH PRESGRAVE, *Vice-President, J. D. Woods and Gordon Ltd., Toronto. Published by McGraw-Hill Book Co. Inc., 330 W 42nd St., New York 36. 6x9, 195 pp. $5.*

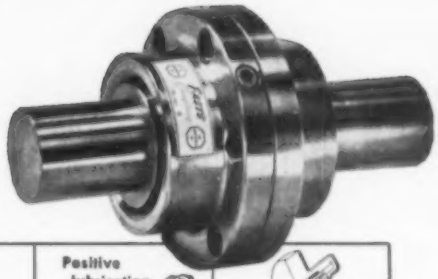
Written for the reasonably qualified timestudy man, this practical manual combines the theory of motion identification and timing with a workable method of applying the resulting time data to manual activities.

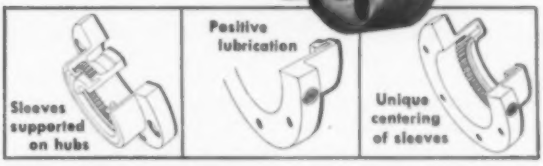
The procedures used to arrive at

(Continued on page 153)

"You know the kind of press action I want, . . . wham! wham! wham! . . ."

FAST'S Model B Coupling





reduces downtime and upkeep for light-to-medium drives!

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., 7105 Scott Street, Baltimore 3, Maryland.

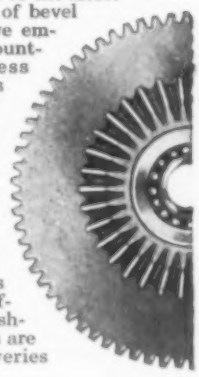
Engineered Products Sold with *Service*

KOPPERS

THE ORIGINAL *FAST'S Couplings*

HOW YOU CAN TAKE ANOTHER LOOK AT

BEVEL GEARS



Designers can now re-consider the use of bevel gears—due to the latest Gleason coniflex system of bevel gear proportions which we employ—to minimize gear mounting problems and for less trouble after assembly. Costs are less by this method, better finishes and smoother gear operations are a result, and because bevel gears are so efficient, they can now be used more extensively than ever before.

We can make bevel gears up to 3" in diameter with up to 16 diametral pitch for such products as instruments, power tools, differentials, appliances, and fishing reels. Process bevel gears are precision engineered, deliveries are prompt.

Send blue prints or specs for prompt estimates to the specialists in the Fine Pitch Field.

PROCESS GEAR COMPANY

4602 W. Fullerton Ave. • Chicago 39, Ill.

109

Rowbottom for Cams

. . . a size and type for every application

Rowbottom service on cams is complete . . . from cooperation on design through final production . . . an *inclusive* service. And Rowbottom's long, specialized experience in cam production and cam production only, is your assurance your specifications will be accurately met.

This experience applies to all types and sizes . . . box, barrel, side or indexing . . . also cams hardened and ground for specially tough service, with bores and shapes exactly to your specifications.

You are invited to make Rowbottom your "Cam Department". Remember: the names "Rowbottom" and "Cams" are synonymous . . . when you think of one you think of the other. So when you come to "Cam Headquarters" you get the benefits which only experience can provide, and the cams which will meet your strictest requirements with utmost adequacy . . . cams which definitely will help you in product improvement.

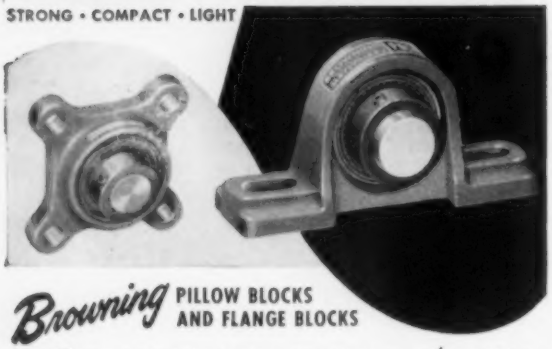
New brochures showing a wide range of cam types produced by Rowbottom are just off the press. Send for them . . NOW!

The ROWBOTTOM MACHINE CO.
30 SHEFFIELD ST., WATERBURY, CONN.

Rowbottom also builds Cam Milling and Cam Grinding Machines for the economical production of cams of all types. Literature sent promptly on request.

NOW . . . BEARING UNITS OF *Malleable*

STRONG • COMPACT • LIGHT



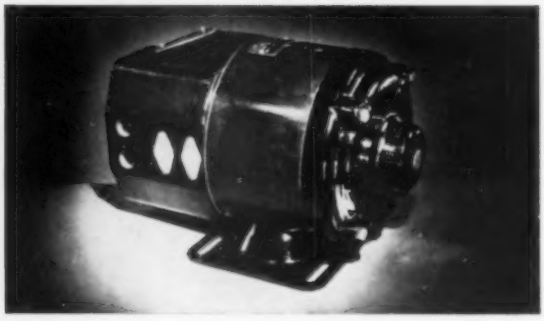
Browning **PILLOW BLOCKS AND FLANGE BLOCKS**

More compact design and consequent lighter weight are achieved in Browning's new pillow blocks and flange blocks by the use of *malleable* housings that are stronger, virtually indestructible. Contain self-aligning ball bearing units, permanently lubricated and sealed; wide inner ring, eccentric locking ring, safety set screw. Your Browning distributor stocks *two heights*, 28 sizes for ½ to 2⅞" shaft, all with elongated bolt slots. Ask for new descriptive Catalog BU-101.

Browning Manufacturing Company, Maysville, Kentucky.

Browning **POWER TRANSMISSION EQUIPMENT**

HEAVY-DUTY DC-TO-AC CONVERSION UNITS



Rated for continuous duty:

Output: 115 volts a-c, 300 to 1500 volt-amps.

Input: 12, 32, 115, or 230 volts d-c.

Output Frequency: 25, 40, 50, 60, 80 cycles.

Voltage Regulation: 20% (with constant input).

Frequency Regulation: 7.5% at 0.8 PF (no load to full load).

Rugged Construction: vibration-resistant bearing mountings; welded-on steel base; dripproof enclosure; heavy-duty ball bearings.

FREE BULLETIN

Ask for GEC-1503. Write Section 634-20, General Electric Co., Schenectady, N. Y.

GENERAL ELECTRIC

the motion times through application of these principles are described, and examples are given of how the resulting time data are used to set standards for manual work either through direct study or through use of elemental standard-time data. A chapter is devoted to the development of special time data that may be used in conjunction with the published data, using as examples the application of standards to clerical activities.

Feedback Control Systems

OTTO J. M. SMITH, *Professor of Electrical Engineering, U. of California, Berkeley. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 6¼x9¼, 700 pp. $13.50.*

This thorough work is written for experts by experts. It starts with short review of theory, then plunges into single feedback, S-plane analogs, multiple loops, power spectra, linear and nonlinear synthesis. Covered are Laplace transforms, Nyquist lines, Taylor's series expansion for stability angle, Routh's criterion, and practically all modern phases of feedback design. Appendix includes RC compensation networks, and there is an index.

Intended for the first year of graduate study, this textbook is designed for the reader who has had at least one previous course in control systems or feedback systems and has studied statistics from the viewpoint of Fourier and Laplace transforms, random gaussian signals, weighting functions, and cross-power spectra.

1957 Supplements to ASTM Standards

Published by ASTM, 1916 Race St., Philadelphia 3. 6x9, over 2,500 pp. $28 per set.

The 1957 supplements, issued in seven parts, give 415 specifications, tests and definitions, which either were issued for the first time in 1957 or revised since their appearance in the 1955 book or the 1956 supplements. Part I is on ferrous metals and covers pipe, castings, tubes, bolting materials, plates, structural and rivet steel, sheet and strip, forgings, concrete reinforcement, metallic-coated steel products, ferro-alloys.

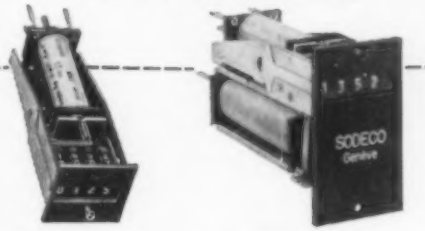
Part II covers copper and copper-base alloys, aluminum and aluminum-

(Continued on page 155)

You get *MORE* than accurate counting with

SODECO Electric Impulse Counters

SODECO just *starts* with counting accuracy. With SODECO Electric Impulse Counters you get many additional built-in advantages which enable you to use them for your toughest counting problems. For example:



SODECO TYPE TCeZ Instantaneous Mechanical Reset
• Just touch the toggle—Counter resets to zero.

SODECO TYPE TCeF Instantaneous Electrical Reset
• Counter resets electrically—instantly.

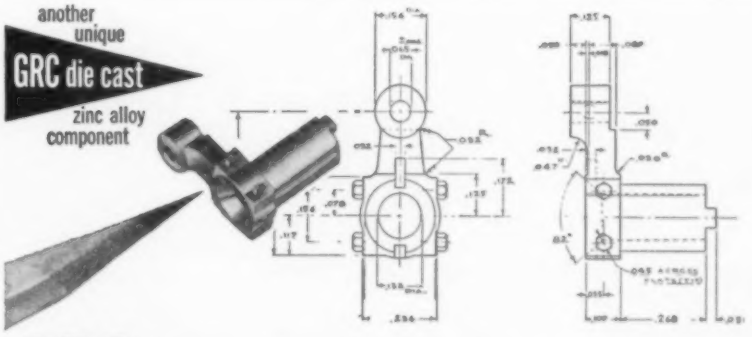
- **Fast—counts up to 25 impulses/sec.**
- **Compact — suitable for flush mounting.**
- **Low power demand — used in electronic circuits.**

Both types are available with auxiliary contacts which allow you to connect them to other counters for applications such as batch counting, recycling, etc.

No matter what your counting problem, you can count on SODECO for the answer. Write for complete information.

LANDIS & GYR, INC.
45 West 45th Street New York 36, N. Y.

another unique **GRC die cast** zinc alloy component



GRC die casting helps Lionel achieve tiny part authenticity

This intricate toy crank was die cast in zinc alloy by GRC in a single automatic operation. Cost? Little more than $5.00 per thousand in lots of 500,000. Result? Produced quicker and more economically than Lionel could themselves.

Less than half an inch overall, it is typical of the many small (maximum is 1¾" ½ oz., no minimum) parts problems solved by GRC's unique techniques. Gries' specialized machines deliver parts ready for use—uniform, accurate, clean—no trimming, no assembly, no scrap loss.

If you have a small parts problem write, wire or phone for GRC's die casting bulletin or send prints for quotation.

World's Foremost Producers of Small Die Castings

GRIES

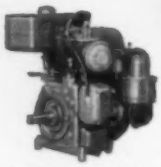
GRIES REPRODUCER CORP.

157 Beechwood Avenue, New Rochelle, N. Y. • NEw Rochelle 3-8600

To meet your Specific need

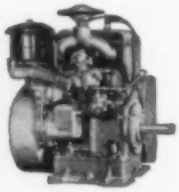
complete power selectivity from 3 to 56 HP

WISCONSIN
HEAVY-DUTY
Air-Cooled
ENGINES



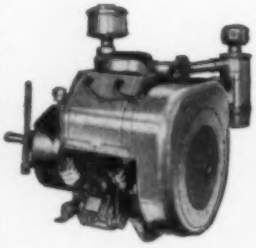
4-cycle single cyl.
3 to 12½ hp.

In selecting an engine for *your* kind of equipment, it's good sense to pick a power unit that is neither *over*-powered nor *under*-powered for the job.



2-cylinder
10 to 18 hp.

The Wisconsin line of Heavy-Duty Air-Cooled Engines provides a complete power range from 3 to 56 hp., in 4-cycle single cylinder, 2- and 4-cylinder models, to fit every power need in this broad bracket. There are no "power blanks" or open spots in Wisconsin model-to-model power continuity.



V-type 4-cyl.
15 to 56 hp.

Here is complete power selectivity *tailored to the job and the equipment*. But of even greater importance are such features as heavy-duty design and construction; traditional high quality in all details; load-lugging high-torque performance and dependable all-weather AIR-COOLING from low sub-zero to 140° F. . . . *plus* exclusive specialization in the manufacture of air-cooled engines, backed by more than 2,000 Approved Service Stations.

You can recommend and specify Wisconsin Air-Cooled Engines with confidence in your good judgment. Write for free copy of Engine Bulletin S-223.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

specialists in
HEATING ELEMENTS

ELECTRO-FLEX
solves another difficult heating problem.

THIS TIME FOR...

This quantity production heating element for W.G.C. heats the nut of a ball screw actuating rod on an airplane landing gear assembly. To melt out ice, it is energized just before landing gear is raised or lowered. It embodies a molded-in thermostat which holds temp. to approx. 250°F.

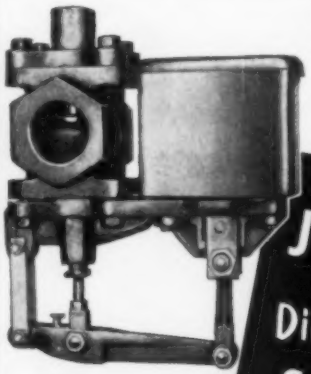
If you have a special heating problem let us solve it for you. We are specialists in light-weight, tough, flexible elements of any shape or size. Units may be designed to operate under high pneumatic pressure. Insulation may be Silicone Rubber or Neoprene. Elements may be immersable or resistant to corrosion. All units meet USAF specifications.

Western Gear Corporation
Lynwood, California
Performance: —65°F. ambient to 450°F. heater temp.
Material: Silicone, vulcanized into precision metal clamp.
Rating: 400 W, 115 V, 40 w/sq. in.

send for free illustrated booklet

Electro-Flex Heat, INC.

83 WOODBINE ST., HARTFORD, CONN. (CHapel 7-2401)
"FIRST with STANDARD ELEMENTS"



OUTSTANDING FOR STEAM SERVICE

JOHNSON
Direct Operated
SOLENOID VALVES

Stainless steel valve and seat.
Sizes: ½" to 3".
Write for facts.

Job after job, these Johnson Direct Acting Solenoid Valves are proving an ideal answer for service on steam lines. Their design removes the solenoid proper from the heat of the line, permits a leverage system with ample power to open against differential pressures up to 150 lbs. There are no pilot valves or auxiliary pistons, and construction is really heavy duty throughout. You will find their inherent simplicity and instant response will solve a lot of operating problems like no other valve can.

THE JOHNSON CORPORATION
813 Wood St., Three Rivers, Mich.

base alloys, magnesium-base alloys, electrodeposited metallic coatings, corrosion tests and general methods of testing.

Part III covers cement, concrete, ceramics, thermal insulation, road materials, waterproofing, soils. Part IV includes paint, naval stores, wood, cellulose, wax polishes, sandwich and building constructions, fire tests.

Part V covers fuels, petroleum, aromatic hydrocarbons, engine antifreezes. Part VI includes rubber, plastics, electrical insulation. Part VII is on textiles, soap, water, paper, adhesives, shipping containers.

Lefax Engineering Formulas and Tables

Published by Lefax, Ninth and Sanson Sts., Philadelphia 7. Looseleaf, 6¾x3¾, 396 pp. $4.75.

Pocket reference manual containing basic formulas, design data and tables for civil, mechanical and electrical engineers. The twelve sections include; mathematics, measures, materials, gauges, mechanics, electricity, hydraulics, structural data, reinforced concrete, pipe, steam tables and mathematical tables.

Nondestructive Testing Symbols

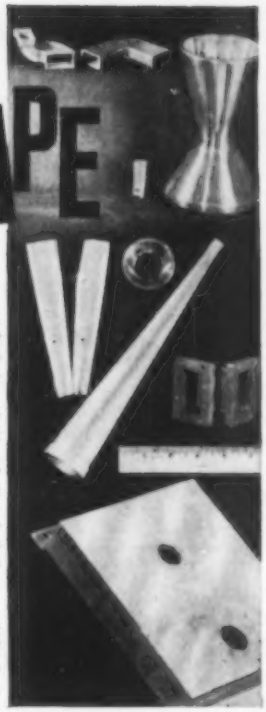
Published by American Welding Society, 33 W. 39th St., New York 18. 6x9, 10 pp. $1.

This publication sets up symbols to be used for specifying nondestructive tests. Symbols for radiographic, magnetic-particle, penetrants, and ultrasonic procedures are included. It is now possible to specify with a single symbol the type of test required.

"It's not that we don't like the design . . . we'd just rather see our competitors use it."

need metal components of

INTRICATE SHAPE . . .



. . . with accuracies to 0.0005 in.?
Let BART LECTROFORM them for you

When shapes are too complex to machine or cast . . . when thin walls and super-fine internal finishes are vital . . . BART Lectroforming is often the answer. And no other process approaches it for maintaining identical dimensions throughout mass production runs.

In BART Lectroforming, your products or parts are built up electrolytically on removable matrices. There are no secondary operations to alter tolerances.

Products successfully Lectroformed include many of "difficult" form for electrical, electronic, and other precision applications, in many metals and metallic combinations.

Explore the vast new designing possibilities of Lectroforming when your product is at drawing-board stage. BART's research and development facilities and experience are at your call.

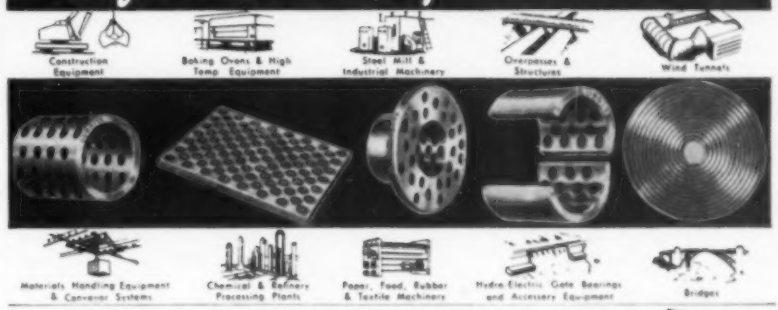
Precision Mechanical Tube-Forming, Too

The F. C. Kent Company, a division of Bart Manufacturing Corporation, offers 44 years' experience in the production of precision-formed tubular parts for the aircraft and electronic industries. Inquiries are invited and catalog is available on request.

BART

MANUFACTURING CORPORATION
ELECTROFORMING • PIPE LINING & COATING • PLATERS
CHEMICAL PUMPS • ENGINEERING DESIGN SERVICES
227 Main St., Dept. P, Belleville 9, New Jersey

ASSURED SELF-LUBRICATING SECURITY
WITH LUBRITE®
Self-Lubricating BEARINGS


Construction Equipment
Baking Ovens & High Temp. Equipment
Steel Mill & Industrial Machinery
Overpasses & Structures
Wind Tunnels
Materials Handling Equipment & Conveyor Systems
Chemical & Refinery Processing Plants
Paper, Food, Rubber & Textile Machinery
Hydro-Electric Gate Bearings and Accessory Equipment
Bridges

Lubrite self-lubricating bearings offer great versatility in hundreds of fields where dependability and superior performance are of prime importance.

Lubrite Bearings, with clean, permanent, maintenance-free self-lubrication are designed to withstand severe loadings, temperature extremes, submersion, corrosion and other adverse conditions.

Lubrite may be just the bearing you need in your designs to obtain better results.

Consult our Engineering Department on your application. No obligation.

Manual No. 41. A 20-page book filled with complete information, technical data, and specifications about Lubrite Self-Lubricating bushings, bearings, and washers for industrial equipment, machinery, and hydro-electric type applications.

Available soon — New Manual No. 56 with complete technical information about LUBRITE SELF-LUBRICATING BUSHINGS, BEARINGS & WASHERS.

Write for your copy.

LUBRITE DIVISION
MERRIMAN BROS., INC.
195 AMORY STREET, BOSTON 30, MASSACHUSETTS

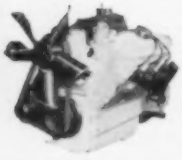
NOW, 3 NEW FORD INDUSTRIAL ENGINES . . .

Up to a MIGHTY 534 cu.in.

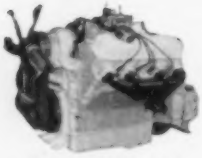
Meet the new Ford Super Heavy Duty V-8's . . . built to handle the big jobs easier, at less cost. The most modern in the industry, they feature new high-turbulence combustion chambers . . . new fuel induction systems . . . new lubrication systems . . . and provide more horsepower per pound of engine weight than ever before possible.

Check Ford's *full line* of 4-, 6- and V-8 cylinder engines. Most are available as engine assemblies or complete power units, foot- or skid-mounted.

Ford "534" V-8



Ford "477" V-8



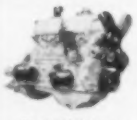
Ford "401" V-8

Ford INDUSTRIAL ENGINES AND POWER UNITS

YOUR JOB IS WELL-POWERED WHEN IT'S FORD-POWERED

Ford "332" V-8

Ford "272" V-8

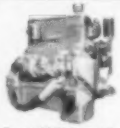


Ford "223" 6-cyl.

Ford "172" 4-cyl.

Ford "134" 4-cyl.

Ford "330" Diesel 6-cyl.



Ford "220" Diesel 4-cyl.

INDUSTRIAL ENGINE DEPARTMENT

FORD Division of FORD MOTOR COMPANY, P. O. BOX 598, DEARBORN, MICHIGAN

SMALL PLASTIC PARTS over 3,000 in open stock

STOCK PARTS FOR RAPID DELIVERY . . . FREIGHT PREPAID ANYWHERE IN THE U.S.

Pipco specializes in small industrial plastic parts (injection molded and extruded) in Nylon, Hi-Density Polyethylene, Polyethylene, Butyrate and Vinyl. Parts include gears, rollers, spacers, wire tips, bumpers, closures for round, square, rectangular, oval and triangular tubing; caps for angle iron, bar and channel steel; extruded plastic welting, "T", "H" and "E" shape extrusions, etc. Custom parts that fit Pipco automatic production processes, are also available.

FREE CATALOG

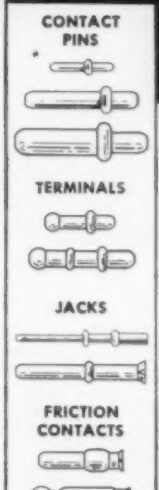
Small parts with a big reputation. Write for our latest catalog, 500A.

PIPCO INTERNATIONAL CORPORATION

1757 Stanford Street — Santa Monica, California

Offices & warehouse stocks at Santa Monica, Chicago and Bridgeport, Conn.

50% SAVINGS with BEAD CHAIN® Multi-Swage Parts



also **PRINTED CIRCUIT MINIATURE PARTS**

Contact pins, terminals, jacks or any small tubular parts. Maximum ¼" diameter x 1¼" length.

Send sketch for quotations.

BEAD CHAIN DRIVES

Low-speed positive drives or motion transfer . . . at far less cost!

Send for Multi-Swage or Bead Chain Drive Catalogs!

THE BEAD CHAIN MFG. CO.

92 Mountain Grove St., Bridgeport 5, Conn.

Boost production . . .
cut fatigue with
Westinghouse Air Circuitry*

***Westinghouse Air Circuitry** is the application of pneumatic control to industrial production operations — a proven method of stepping up machinery output . . . increasing operator efficiency. These pneumatic devices are low in cost . . . easy to install . . . extremely accurate and reliable.

"H" CONTROLAIR® VALVES:
3- and 4-way directional valves—accurate pressure control in small increments—hand, foot, knob, or cam operation—maximum delivery pressure: 60, 100 psi—port sizes: ¼" ips—maximum operating temperature: 200°F.

THREE-POSITION CYLINDERS:
noncushioned—3 stroke positions—foot and swivel mounted—2"-6" in diameter—maximum operating pressure: 250 psi.

MULTI-POSITION CYLINDERS:
noncushioned—4, 5, or 7 stroke—small diameter—tough, corrosion-resistant construction—maximum operating pressure: 250 psi.

Consult your nearest Westinghouse Air Brake Distributor. He's listed in the classified phone directory under "Cylinders: Air."

Westinghouse Air Brake
COMPANY
Industrial Products Division
WILMERDING PENNSYLVANIA

Current Reprints

Selected articles in recent issues have been reprinted in convenient form for filing. As long as the supply lasts, readers in US and Canada can secure one copy of any of these reprints without charge, by using one of the Reader Service Cards bound inside the back cover. Note that the card must be used within 60 days of publication date. If more than one copy is needed, see price list at end of this listing.

While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

Semiconductor Rectifiers
Comparison of both germanium and silicon as low-cost rectifiers. May 12, '58, p. 89. Circle No. E 24

Midget Batteries
Specialized power packages where current or voltage needs can be kept low. May 12, '58, p. 72. Circle No. E 23

Sandwich-panel Facing Materials
Apr. 28, '58, p. 80. Second of three articles gives data for selecting the skin material. Circle No. E. 22

Fan Selection
Apr. 28, '58, p. 92. Three fan laws; charts, tables and sample problems. Circle No. E 21

Silicone Rubber Parts
Tips on curing methods, shape of parts and material selection for best service. Apr. 14, '58, p. 69. Circle No. E 20

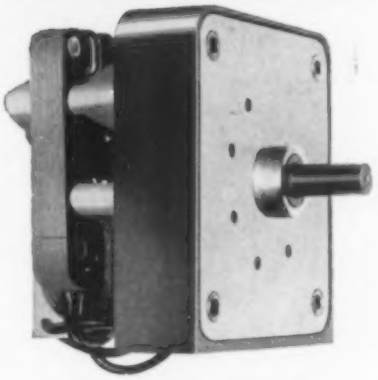
Pressure Drops in Air Valves
Technique estimates pressure losses in a pneumatic system, component by component. Charts give K-factors for actual valves and fittings. Apr. 14, '58, p. 74. Circle No. E 19

Plastics for Abrasion Resistance
Table lists specific properties of elastomers and rigid plastics that resist abrasion best. Mar. 31, '58, p. 105. Circle No. E 18

Instrument Bearings for 300 F and Up
What happens to ball bearings operated above 300 F; special materials and lubricants that give better performance. Feb. 3, '58, p. 72. Circle No. E 17

(Continued on page 159)

put HEINZE in your designs



NEW HEINZE GEARMOTORS with choice of Drives–Speeds

Powerful, compact, quiet . . . Heinze Gearmotors offer four sub-fractional horsepower driving motors: 2 and 4 pole induction; universal; reversing. Speeds range from approximately 700 rpm down to 1 revolution in eight minutes. Geartrain may be enclosed or open, base or panel mounted. Gears, pinions and shafts are made from finely tempered and hardened steel. Felt oil reservoir in geartrain guards against oil leakage. Oil-impregnated bronze bearings insure long, trouble-free operation.

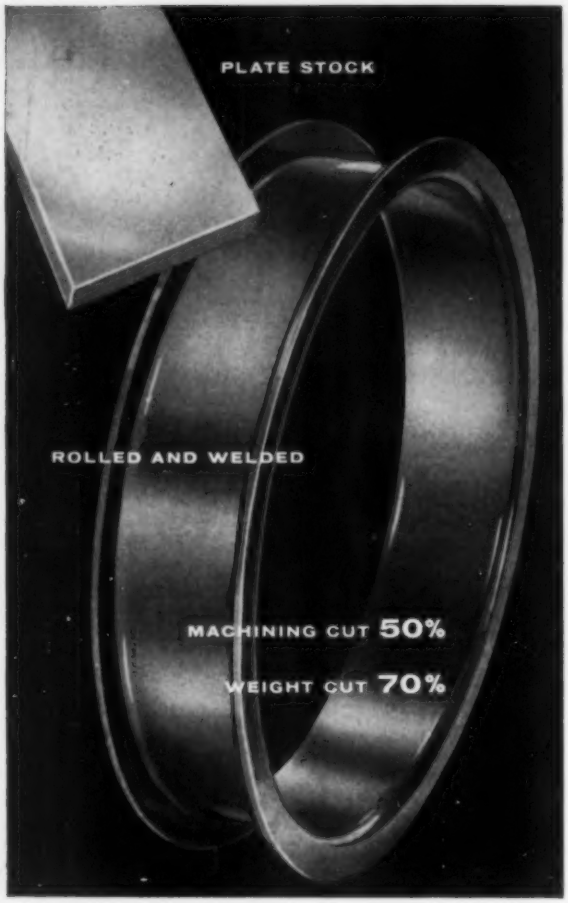
Send coupon for complete technical data

HEINZE ELECTRIC COMPANY
685 Lawrence St., Lowell, Mass.
Sub-Fractional Horsepower Motors and Blowers

HEINZE ELECTRIC COMPANY, Dep't F
685 Lawrence Street, Lowell, Mass.

Please send me literature and prices on Heinze Gearmotors.

Name & Title .....
Company .....
Street & No. .....
City & State .....



For cost-saving design . . .

DRESSER "Know-How"

runs rings around old methods!

Take this expansion clutch ring, for instance!

The manufacturer reduced machining by 50%, cut weight 70% by switching from steel castings to Dresser Rings.

Dresser starts with a flat plate. Flanges it, rolls it, dickers it and flash welds it into an accurately sized ring. As delivered by Dresser, it needs minimum machining inside, and minimum stock removal outside. The angle between the flanges and the ID is held dead square.

If you can visualize your product, or parts, as a roll-formed and flash-welded unit, we may be able to help you make a better product at less cost. Send your sketch or print, we'll make recommendations at no cost to you. Or ask for free Dresser Flash Welded Rings Catalog.

DRESSER®

ONE OF THE DRESSER INDUSTRIES

Manufacturing Division
119 Fisher Avenue, Bradford, Pa.

ENGINEERS—SCIENTISTS

R & D Opportunities in CALIFORNIA with Sylvania

Creative assignments are offered by Sylvania's Mountain View Laboratories. If you qualify for any of the positions below, write us today.

ELECTRONIC ENGINEERS

Advanced R&D in the fields of electronic counter-measures and electronic systems; responsible for circuit and equipment design and development in the areas of transmitters, receivers, analyzers, direction finders, data handling, RF circuits and antennas.

MECHANICAL ENGINEERS

To work with project teams doing mechanical development in varied areas including servo and power gearing, heat transfer, fabrication, human engineering, electronic packaging, antenna design

SYSTEMS ENGINEER

Perform advanced systems analysis and synthesis applying background in EE, math or physics to problems in the areas of radio and microwave techniques.

PHYSICIST

Application of electromagnetic theory to problems in radio wave propagation and microwave antennas and component development.

MICROWAVE TUBE SPECIALIST

To perform advanced R&D on special purpose tubes such as Klystrons, Travelling Wave Tubes and Backward Wave oscillators.

There are also openings for

PRODUCT ENGINEERS
FIELD ENGINEERS
MATHEMATICIANS
STATISTICIANS

Sylvania is only 5 miles from Stanford University . . . and our liberal employee benefit program includes company assistance with tuition for advanced study. Salaries are commensurate with training and experience.

MOUNTAIN VIEW LABORATORIES

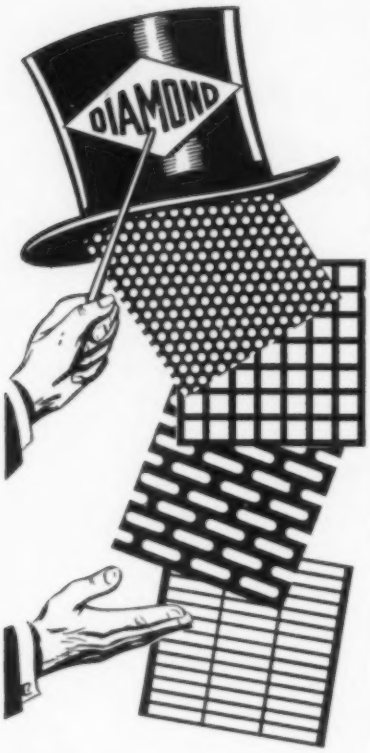
Electronic Defense Lab.
Reconnaissance Systems Lab.
Microwave Physics Lab.
Microwave Tube Lab.

Please send your resume to
Mr. J. C. Richards

SYLVANIA

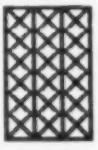
SYLVANIA ELECTRIC PRODUCTS INC.

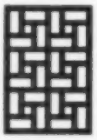
P. O. Box 1296
Mountain View, California



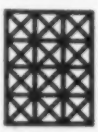
Top-Hat Quality IN Perforated Metal

The popular Diamond Perforated-metal patterns shown above are only a few of the many illustrated and described in our 32-page Catalog No. 39. All of these standard patterns are available in a wide range of unit-opening sizes and we are always equally pleased to quote on original designs of any type or size.

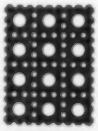




Catalog 39 also illustrates and describes our high-quality lines of *Ornamental Cane*, Perforated-Metal Sheets for Acoustical installations and Heavy-Duty Architectural Grilles. Write, today, for a free copy.



Correspondence is especially invited regarding ANY requirement for perforated-metal panels or parts. We are equipped to fabricate special sections to any desired extent and welcome opportunities to make money-saving suggestions.



DIAMOND MFG. CO.
WYOMING WILKES-BARRE AREA PA.

Manufacturers of DIAMONTEX, the Perforated Metal Lay-In Panel for better Acoustical Ceilings. New Bulletin No. 47 gives complete illustrated information. Write for free copy.

Current Reprints ..... continued

Textured Steel
Types available; when, where and how to use it; two new processes. Mar. 17, '58, p. 73. Circle No. E 15

Which Adhesives for What
How to apply them and to what metals; with data tabulated for fast reference. Mar. 17, '58, p. 79. Circle No. E 14

7 Ways to Start High-inertia Loads
Large table analyzes relative performance of each basic method, as an aid in matching a specific load condition. Mar. 3, '58, p. 75. Circle No. E 12

Which Way to Make a Cam
A recognized authority shares his experience by means of a tabulation covering characteristics of 31 methods. Mar. 3, '58, p. 67. Circle No. E 10

QUANTITY PRICES

For single shipments of any one title to one address, on orders accompanied by remittance, quantity orders will be supplied at the following prices as long as the supply lasts:

Quantity	Price per Copy
5	$0.25
25	0.20
50	0.15
100	Write for quotation

Shipments will be made promptly from stock, and prices include shipping charges. This service is offered only on request from US and Canada. Make checks payable to PRODUCT ENGINEERING, and address orders to Reader Service Dept., PRODUCT ENGINEERING, 330 West 42nd St., New York 36, N. Y.

"Sure we have an incentive plan. Work hard and you won't be fired."

O-M Cylinders give power new dimensions in close quarters

Compared with cylinders of conventional design, having the same size bore, and activated by the same operating pressure, O-M's original Internal Key-type Cylinders develop more power in ⅓ less space on both air and hydraulic circuits.

These compact, powerful components, that fit where others won't, are ruggedly constructed to stand up under protracted service within a wide range of operating pressures. The O-M Internal Locking Key simplifies disassembly, inspection, and service with no alignment problems in reassembly. Besides, the ports can be oriented to any position.

The unique O-M design also assures maximum versatility. By using a majority of standard parts, you get the advantage of "special" cylinders designed to do your job better at a very nominal cost over standard cylinders. These and other engineering advantages and economies of O-M Internal Key-type Cylinders suggest uses in a wide variety of original equipment.

O-M Internal Key-type Air and Hydraulic Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Completely interchangeable parts and mounts. Immediate delivery on many sizes.

Mail Coupon TODAY *for Bulletins 101A (O-M Internal Key-type Air and Hydraulic Cylinders), and 105 (O-M Series T-H Heavy-duty Hydraulic Cylinders).*

ORTMAN-MILLER MACHINE CO
15 143rd Street, Hammond, Indiana
☐ Have representative call
☐ Send Bulletins 101A and 105

Name_____ Position_____
Company_____
Address_____
City_____ Zone_____ State_____

BEFORE...
Separate Bolts, Nuts and Washers complicate inventories, increase assembly costs.
AFTER...
Washers as integral parts of bolts and nuts eliminate problems, speed assembly at lower cost.

Save Money

by simplifying fastener design

Here is a simple application of a basic bolt making principle which is affecting substantial savings for a number of manufacturers.

These savings, resulting from simplified design, are realized in every step of the operation from lower first cost of the fasteners through inventory to final assembly. Totalled, they are well worth while.

There are many other basic principles . . . often overlooked in designing and specifying fasteners, which are of importance cost-wise.

You'll find them in our new booklet, "How to specify fasteners . . . and save". Filled with drawings and charts, it makes a handy guide in designing or buying any headed parts.

If you can use a copy, write to North Tonawanda or ask a Field Representative.

BUFFALO BOLT COMPANY

Division of Buffalo-Eclipse Corporation

North Tonawanda, N. Y. • Princeton, Illinois

MAKING BOTH FASTENERS AND FRIENDS FOR 100 YEARS

● *3 convenient service centers*

WESTERN OFFICE	EASTERN OFFICE	CENTRAL OFFICE
Chicago	New York City	North Tonawanda
HArrison 7-2178	REctor 2-1888	JAckson 2400 (Buffalo)

Index of PRODUCTS ADVERTISED

In This Issue

After reading the advertisements classified below . . . MORE DETAILED INFORMATION about these products can be obtained by using the READER SERVICE CARD

A

Actuators
Mechanical 55
Aluminum Alloys 8-9
Aluminum Coated Sheet & Strip (see Steel, Coated)
Assemblies
Hydraulic 18
Pneumatic 18

B

Bars
Metal 65
Bearings
Ball . . . 11, 16, 27, 34, 51, 64, 70, 107 136
Miniature 136
Needle 34, 107
Roller 1, 11, 16, 34, 64, 107
Self-Lubricating 60, 155
Sleeve 142
Bellows 95, 130
Belts, Timing 100
Belts, V 32-33, 100
Bi-Metal 150
Bolts 54, 144, 160
Brakes
Hydraulic 148
Bushings 155

C

Cams 152
Capacitors 49
Castings 121
Chains
Bead 156
Conveyor 112
Roller 112
Chemical Treatments 57
Closures 111
Clutches
Mechanical 166
Coatings 57
Cold Headed Parts 124
Controls
Electrical 102
Electronic 40
Mechanical 42
Conveyor Belts 116
Copper & Copper Alloys 105
Counters 153
Couplings
Hose 18
Mechanical 151, 166
Tube 18
Cylinders
Hydraulic 147, 159
Pneumatic 147, 157, 159

D

Decalcomanias 148
Die Castings 122, 134, 153
Drafting
Machines 31
Supplies 113
Drives
Variable Speed ..... 2nd Cover, 143

E

Engineering Services (see also Production Services) 6, 129, 150
Engines 114, 154, 156
Extrusions
Metallic 36

Index of

PRODUCTS ADVERTISED

In This Issue

•

F

Fabricated Plastics (see Plastics, Fabricated)
Fabricated Steel (see Sheet Fabricated, Structural Forms & Shapes, Weldments)
Fastening Methods...10, 38, 118, 126, 146
Filters
Air ... 165
Fittings, Hose, Pipe & Tube...18, 123
Flexible Couplings ... 112
Forgings...14-15, 28, 61, 105, 121

G

Gages, Pressure or Vacuum ... 50
Gear Motors (see also Motor Reducers) ...117, 157
Gears ...133, 140, 151, 164
Generators
D-C ... 152

H

Heating Units ...120, 154
Hydraulic Fluids ... 43

J

Joints
Universal ...139, 162

L

Lamps, Indicator ... 108
Laminated Metals ... 105
Laminated Plastics (see Plastics, Laminated)
Lubricants ... 57
Lubricating Equipment ... 165

M

Metal Forming ... 155
Metal, Pre-Finished ... 131
Moldings
Plastics (see Plastic Parts)
Powdered Metal (see Powdered Metal Parts)
Rubber (see Rubber Parts)
Molybdenum Alloys ... 41
Motor Reducers (see also Gear Motors) ... 117
Motor Starters ... 29
Motors, A-C
Fractional...53, 66, 117, 129
Integral ...53, 129
Sub-Fractional ...66, 138
Motors, D-C
Fractional...53, 63, 66, 117, 129
Integral ...53, 63, 129
Sub-Fractional ... 66
Motors, Hydraulic ... 13

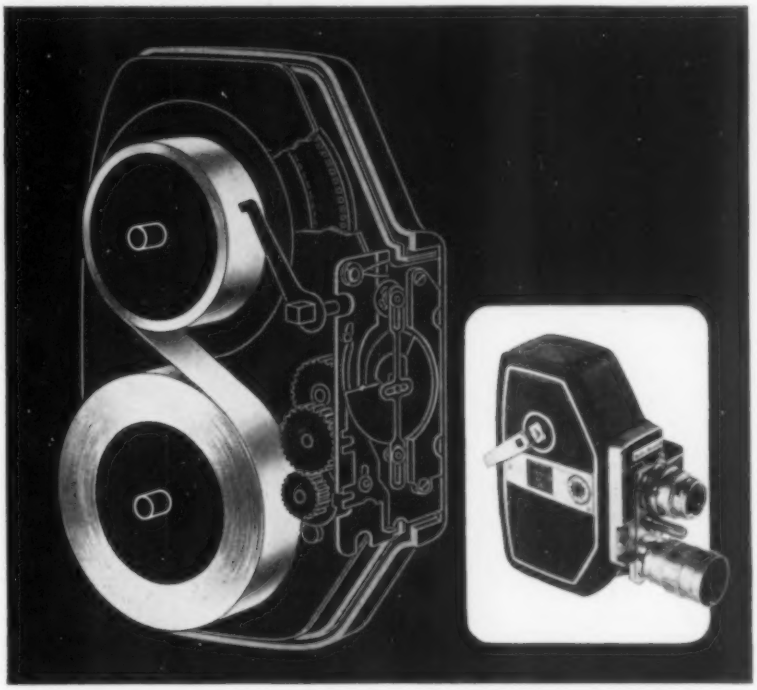
N

Name Plates ... 148
Nuts ... 144

P

Packings ... 43
Perforated Metals ... 159
Phosphor Bronze ... 109
Pillow Blocks ...62, 152
Pilot Lights ... 40
Pins ... 118
Plastic Parts ...132, 156
Plastics ...119, 141
Plastics Fabricated...30, 68, 110, 132
Plastics Laminated...30, 48, 68, 110

(Continued on p. 162)



New Bell & Howell Movie Camera

DRIVEN BY A NEG'ATOR* MOTOR

Another top motion picture camera manufacturer has adopted the NEG'ATOR Motor as a camera drive unit.

As shown above, Bell & Howell engineers have designed a NEG'ATOR Spring Motor and have applied this motor to their new Series 240 Movie Camera. By doing so, they gained the following distinct advantages.

. . . *longer film run per wind.* The NEG'ATOR drives 32 feet of film per wind or 80 seconds of continuous shooting at normal speed of 16 frames per second.

. . . *no "jump" or "skip."* The NEG'ATOR solves an old mechanical motor problem by releasing spring energy smoothly without intercoil friction.

. . . *excellent speed regulation.* The NEG'ATOR provides a maximum output torque of 4.0 lb.-in. at full wind and maximum torque decrease is only 0.8 lb.-in. (20%) during entire output run.

. . . *simplified mechanism.* Bell & Howell engineers took advantage of the NEG'ATOR'S level torque curve and designed an ingenious, low-torque, loose-ball governor which saves space and gives excellent speed regulation.

This application represents still another instance where a NEG'ATOR Spring provided the means for product improvement at reduced cost. Many other such examples are included in Hunter Bulletin 310N. Why not send for a copy now?

*NEG'ATORS *is a registered trade mark of Hunter Spring Company.*

HUNTER SPRING COMPANY

5 Spring Avenue, Lansdale, Pennsylvania

Manufacturers of: Precision Springs, NEG'ATOR & FLEX'ATOR Constant-Force Springs, Stampings & Assemblies, Retriever Reels, Force Gages, and Wire Fatigue Testers

Make your next connection with

asg UNIVERSAL JOINTS

They are made to provide smooth, more efficient transmission of power and are available from stock in 13 sizes with bored or solid hubs ranging from .375" to 4.000". Special bores, bores with keyways or setscrews are available upon special order.

The close limits to which all parts are held assure maximum load carrying capacity with durability and long life. All parts are made of preheat-treated alloy steel and are precision ground to insure high quality and interchangeability of components. Joints with hub diameters of .750" and larger have a self-closing snap ball oiler while the small pin is held in place with a self-locking snap ring. The snap ring simplifies assembly and disassembly.

Send today for Bulletin No. 527 describing the full line of ASG Universal Joints available from your nearest distributor.

AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY HARVEY, ILLINOIS, U.S.A.

Index of

PRODUCTS ADVERTISED

In This Issue

(Continued from p. 161)

•

Powdered Metal Parts....4th Cover, 52, 60, 122
Power Packs
  Electrical & Electronic 127
Pressure Switches 50
Pumps
  Liquid.....13, 44, 47, 146, 149

R

Ratchets 140
Regulators
  Pneumatic 148
Relays 49, 137
Reproduction Equipment 31
Reproduction Supplies 113
Resistors 49
Retaining Rings 115
Rheostats 49
Rings 121, 145, 158
Rivets 10
Rod Ends 16
Rods
  Nonmetallic 30, 68
Rubber 39, 46, 146
Rubber Parts.....3rd Cover, 46
Rust Proofing 57

S

Screws.....38, 98, 124, 144
Seals .....3rd Cover, 37, 128
Seating Work Equipment..... 142
Sheaves 32-33
Sheets
  Metal 2, 65
  Plastic 30, 68
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.).. 160
Speed Increasers & Reducers..2nd Cover
Splines 55
Springs 161
Sprockets 112, 140
Stampings 150
Steel
  Alloy 45
  Coated 2, 35
  Carbon 17
  Stainless.....17, 36, 65
  Tool 45
Strip, Metallic 65, 109
Switches 40, 49, 58

T

Terminals & Terminal Boards..... 163
Thermometers 50
Thermostats.....4, 125, 150
Timers 56, 132
Tracing Paper 113
Transducers 6
Transformers 49
Tubing
  Flexible Metal 126
  Plastic 30, 68
  Seamless 45, 59
  Welded 2

V

Valves
  Air.....123, 148, 157
  Control 125, 157
  Solenoid 135, 154
Vibration Dampers
  Mechanical 142

W

Washers 52, 155
Weldments.....145, 158
Wire 12, 65, 105
Wire Cloth 116
Wiring Devices 163

Z

Zinc Coated Sheets 35

INDEX TO

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

A

AMP, Inc. 163
Ace Plastic Co. 132
Acme Chain Corp. 112
Advance Stamping Co. 150
Allegheny Ludlum Steel Corp. 36
Allis-Chalmers Mfg. Co. 63
Aluminum Co. of America 126
American Nickeloid Co. 131
American Welding & Mfg. Co. 145
Amforge Div., American Brake Shoe Co. 14-15
Armco Steel Corp. 2
Automotive & Aircraft Div., American Chain & Cable Co. 42

B

Baldwin-Lima-Hamilton Corp., Standard Steel Works Div. 121
Bart Mfg. Corp. 155
Bead Chain Mfg. Co. 156
Bendix Aviation Corp., Eclipse Machine Div. 146
Berry Hydraulics Div., Oliver Tyrone Corp. 13
Bethlehem Steel Co. 54
Bodine Electric Co. 66
Bridgeport Brass Co. 105
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. 95
Browning Mfg. Co. 152
Bruning Co., Inc., Charles 31
Bruning Co., The 147
Buffalo Bolt Co., Div., Buffalo-Eclipse Corp. 160
Bushings, Inc. 142

C

C. E. M. Co. 118
Cambridge Wire Cloth Co. 116
Cameron Iron Works, Inc. 61
Century Electric Co. 53
Chrysler Corp., Amplex Div. 60
Clare & Co., C. P. 137
Cleveland Worm & Gear Co. ..... 2nd Cover
Climax Molybdenum Co. 41
Continental Diamond Fibre Co., Subs., Budd Co. 110
Cutler-Hammer, Inc. 40

D

De Laval Steam Turbine Co. 47
Diamond Mfg. Co. 159
Dodge Mfg. Corp. 62
Dresser Mfg. Div., Dresser Industries, Inc. 158

E

Eastman Kodak Co., Graphic Reproduction Div. 113
Eastman Mfg. Co. 18
Electro-Flex Heat, Inc. 154
Emerson Electric Mfg. Co. 129

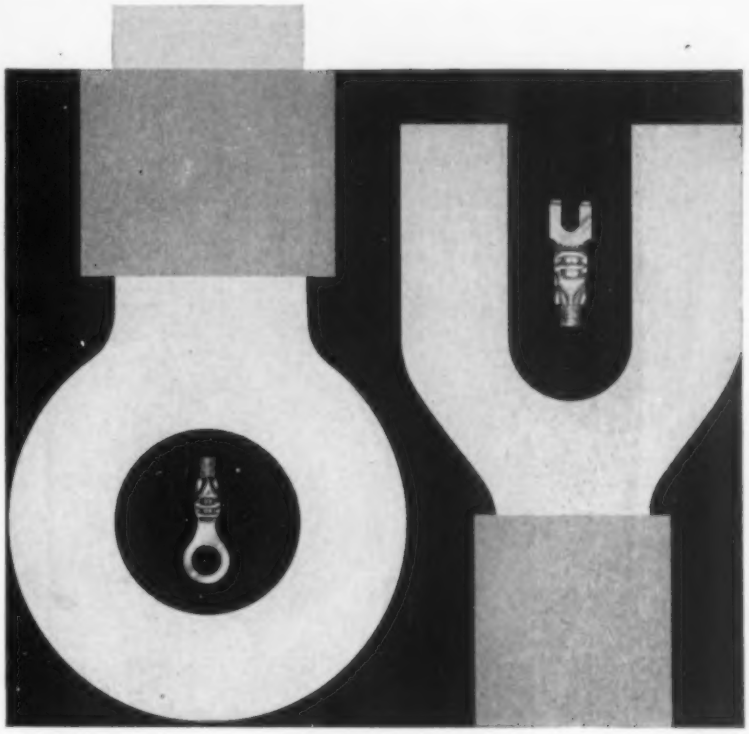
F

Fafnir Bearing Co. 51
Fairbanks, Morse & Co., Pump Div. 44
Fairfield Mfg. Co. 164
Federal-Mogul Div., Federal-Mogul-Bower Bearings, Inc. 52
Ford Motor Co., Industrial Engine Dept. 156
Formsprag Co. 166
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. 130

G

Gear Grinding Machine Co. 139
General Electric Co., Apparatus Dept. 152
General Electric Co., Miniature Lamp Dept. 108
General Industries Co. 138
Gits Bros. Mfg. Co. 37

(Continued on Pg. 164)



For perfect insulated termination . . .

faster . . . specify the A-MP®

PRE-INSULATED DIAMOND GRIP terminal

If you need terminals with bonded insulation—if you need corrosion resistance and wire-supporting vibration resistance—you have it instantly in one closure of A-MP's matched crimping tool. Only one lightning-quick step for crimp-sure optimum strength and conductivity. A-MP PRE-INSULATED DIAMOND GRIP Terminals exceed the most rigid military and commercial specifications.

A-MP's precision-engineered terminals are matched to precision-engineered tools that make an exact crimp every time, never too little, never too much. Perfect terminations—whether you need one or a million. No great operating skill necessary. A-MP's match-mated tooling does all the work and at lower installed cost than other methods of wire termination. Wire range is from No. 26 to No. 10.

To solve your wire-end problems, we maintain an international engineering service.

For the full story on the A-MP PRE-INSULATED DIAMOND GRIP line, send for our catalog.

AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

GEAR PROBLEMS?

—check with

FAIRFIELD!

GEAR PERFORMANCE to match the ever-increasing power and speed of modern machines is a Fairfield specialty. This is possible because Fairfield has long held a position of leadership in utilizing the most advanced methods, equipment, and techniques for producing better gears. By keeping apace with modern engineering trends, Fairfield renders an invaluable service to many of the nation's leading machinery builders.

If you have a gear problem, check with Fairfield. Our engineers are well-qualified to give you expert recommendations. CALL OR WRITE.

SPUR GEARS—Straight, helical, and internal. Sizes from 16 pitch, 1½" dia., to 1½ pitch, 36" dia.

HERRINGBONE—(Fellows Type). Sizes from 1½" to 15"

SPIRAL BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

STRAIGHT BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

HYPOID—Sizes from 1½" to 28" dia.

ZEROL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 21" dia.

WORMS AND WORM GEARS—Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS—Lengths to 72".

DIFFERENTIALS—3,000 to 500,000 inch pounds capacity.

Note: All of the sizes above are approximate.

FAIRFIELD MANUFACTURING CO.

2305 S. Concord Rd. Lafayette, Indiana

TELEPHONE: 2-7353

Ask for interesting, illustrated bulletin.

Gears and Differentials Made to Order for:

TRACTORS • HEAVY DUTY TRUCKS • AGRICULTURAL MACHINERY • POWER SHOVELS AND CRANES
MINING MACHINES • ROAD GRADERS • BUSES • STREET SWEEPERS • INDUSTRIAL LIFT TRUCKS

INDEX TO ADVERTISERS

(Continued from Pg. 163)

Gleason Works 133
Grace & Co., W. R., Polymer Chemical Div. 119
Gries Reproducer Corp. 153

H

Haydon Co., A. W. 132
Helm Co. 16
Heinze Electric Co. 157
Hoover Ball & Bearing Co. 27
Houghton & Co., E. F. 43
Hubbell, Inc., Harvey, Machine Screw Dept. 124
Huck Mfg. Co. 146
Hunter Douglas Aluminum Corp. 28
Hunter Spring Co. 161
Hyatt Bearings Div., General Motors Corp. 1

I

Industrial Timer Corp. 56

J

Johnson Corp. 154
Jones & Laughlin Steel Corp., Stainless Steel Div. 65

K

Kaiser Aluminum & Chemical Corp. .. 8-9
Kaydon Engineering Corp. 107
Kohler Co., Engine Div. 114
Koppers Co., Inc., Fast's Coupling Dept. 151

L

Lamb Electric Co. 117
Landis & Gyr, Inc. 153
Link-Belt Co. 11

M

McLouth Steel Corp. 17
Madison-Kipp Corp. 134
Marotta Valve Corp. 148
Merriman Brothers, Inc., Lubrite Div. 155
Meyercord Co., Name Plate Div. 148
Miller Co. 109
Milsco Mfg. Co. 142
Minneapolis-Honeywell Regulator Co. 102
Minnesota Rubber Co. ..... 3rd Cover
Mobay Chemical Co. 39

N

National Acme Co., Electric Mfg. Div. 58
National Aniline Div., Allied Chemical Corp. 141
National-Standard Co. 12
National Tube Div., U. S. Steel Corp. 59
New Departure Div., General Motors Corp. 70
Norgren Co., C. A. 165

O

Ohio Rubber Co. 46
Ohmite Mfg. Co. 49
Ortman-Miller Machine Co. 159

P

Parker-Kalon Div., General American Transportation Corp. 38
Parker Rust Proof Co. 57
Parker White Metal Co. 122
Pennsylvania Flexible Metallic Tubing Co., Inc. 126
Perfection Gear Co., American Stock Gear Div. 162
Perkins Machine & Gear Co. 140
Pipco International Corp. 156
Powers Regulator Co., The 125
Precision Rubber Products Corp. 128
Process Gear Co., Inc. 151
Proctor Electric Co., Equipment Div. 150
Protective Closures Co., Inc. 111

INDEX TO ADVERTISERS

R

Reeves Pulley Co., Div., Reliance Electric & Engineering Co. 143
Reuland Electric Co. 127
Rochester Mfg. Co., Inc. 50
Rowbottom Machine Co. 152

S

SKF Industries, Inc. 64
Saginaw Steering Gear Div., General Motors Corp. 55
Schrader's Son, A., Div., Scovill Mfg. Co., Inc. 123
Shakeproof Div., Illinois Tool Works 98
South Chester Corp., Southco Div. 10
Southern Screw Co. 144
Spaulding Fibre Co., Inc. 30
Split Ballbearing Div. of MPB, Inc. .. 136
Square D Co. 29
Standard Steel Works Div., Baldwin-Lima-Hamilton Corp. 121
Statham Instruments, Inc. 6
Stevens Mfg. Co., Inc. 4
Synthane Corp. 68

T

T A Mfg. Corp. 146
Taylor Fibre Co. 48
Timken Roller Bearing Co., Steel & Tube Div. 45
Torrington Co., Bearings Div. 34

U

U. S. Graphite Co., Div. of the Wickes Corp. ..... 4th Cover
U. S. Rubber Co., Mechanical Goods Div. 100

V

Valcor Engineering Corp. 135
Viking Pump Co. 145

W

Wagner Electric Corp. 148
Waldes Kohinoor, Inc. 115
Watlow Electric Mfg. Co. 120
Weirton Steel Co., Div., National Steel Corp. 35
Westinghouse Air Brake Co., Industrial Products Div. 157
Wisconsin Motor Corp. 154
Worthington Corp. 32-33

PRODUCT ENGINEERING ADVERTISING SALES STAFF

Atlanta 3 . . . M. H. Miller, 1301 Rhodes-Haverty Bldg., Jackson 3-6951

Boston 16 . . . M. A. Williamson, Jr., 350 Park Square Bldg., Hubbard 2-7160

Chicago 11 . . . Mid-Western Adv. Sales Manager, A. E. Meanor; R. W. Bruley, L. Anderson, 520 N. Michigan Ave., Mohawk 4-5800

Cleveland 13 . . . A. F. Tischer, 1164 Illuminating Bldg., 55 Public Square, Superior 1-7000

Dallas 1 . . . E. E. Schirmer, 901 Vaughn Bldg., 1712 Commerce St., Riverside 7-5117

Denver 2 . . . John W. Patten, 1740 Broadway, Mile High Center, Alpine 5-2981

Detroit 26 . . . P. B. Robinson, 856 Penobscot Bldg., Woodward 2-1793

Los Angeles 17 . . . H. L. Keeler, 1125 West Sixth St., Madison 6-9351

New York 36 . . . B. K. Adams, J. C. Taney, R. G. Wallace, 500 Fifth Ave., Oxford 5-5959

Philadelphia 3 . . . D. G. Jones, K. S. Willadsen, 6 Penn Center Plaza, Locust 8-4330

Pittsburgh 22 . . . C. F. Leveroni, 1111 Oliver Bldg., Atlantic 1-4705

St. Louis 8 . . . R. W. Bruley, 3615 Olive St., Continental Bldg., Jefferson 5-4867

San Francisco 4 . . . W. C. Woolston, 68 Post St., Douglas 2-4600

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.
EMPLOYMENT OPPORTUNITIES 158
Index to Advertisers begins on P 163
Products Index begins on P 160

12 NEW ¾" and 1" Norgren AIR LINE FILTERS

Make Norgren the most complete line available!

For ¼" through 1½" Pipe Sizes
Up to 300° F Operating Temperature
Norgren
Removable Bowl
5 to 250 psi Operating Pressure
Automatic or Manual Drain
Highly Efficient Water Removal

REDUCE COSTLY WEAR ON YOUR AIR EQUIPMENT

...with Norgren Air Line Filters

- **Now, 98 Models to choose from**—¼", ⅜", ½", ¾", 1", 1¼" and 1½".
- **Abrasive Solids and Corrosive Liquids** are removed from air lines, reducing equipment wear, repair and replacement costs.
- **Transparent or Metal Bowls**
- **Choice of 4 Filter Elements**—74, 64 or 25 micron...5 micron available in some sizes.
- **Automatic or Manual Drain**

For complete information about Norgren Air Line Filters, call your nearby Norgren Representative listed in your telephone directory—or **WRITE FOR No. 900 CATALOG**

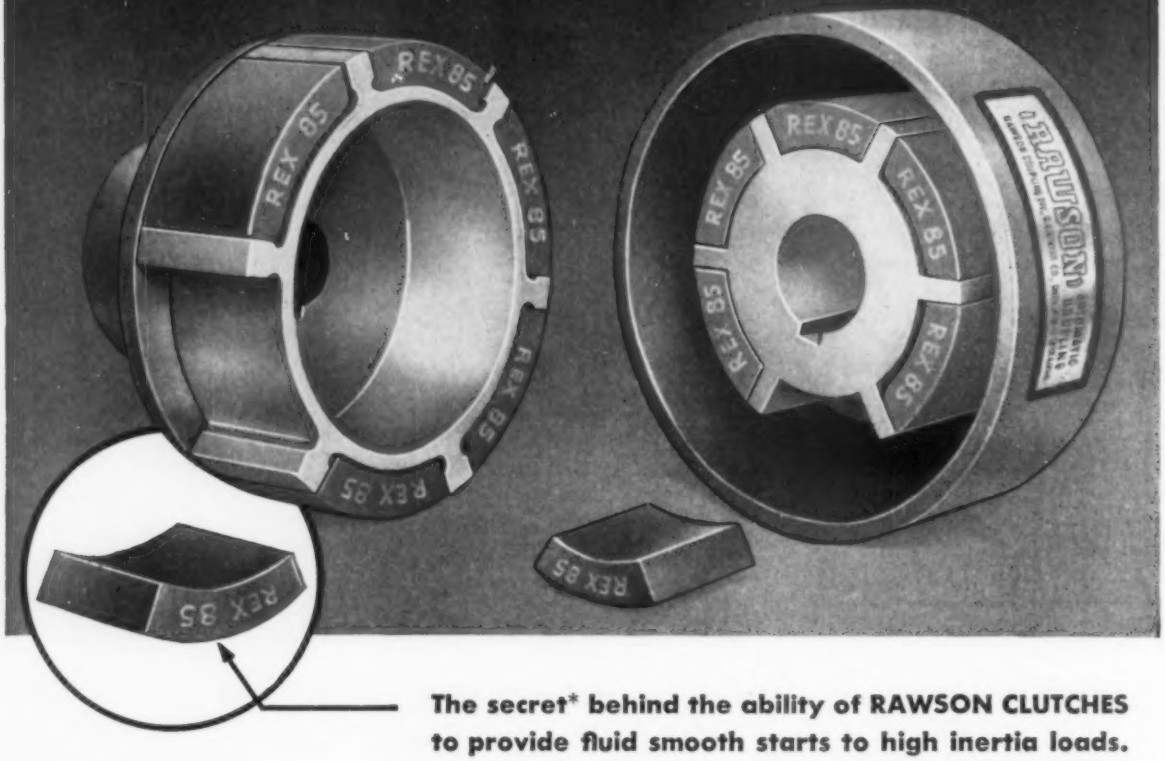
If it's Norgren...It's Dependable.

C. A. NORGREN CO.

3428 SO. ELATI STREET • ENGLEWOOD, COLORADO

NEW RAWSON

Automatic Centrifugal Clutches and Clutch Couplings



The secret* behind the ability of RAWSON CLUTCHES to provide fluid smooth starts to high inertia loads.

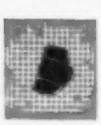
The new Rawson, manufactured under the original Rawson Patents, incorporates *exclusive metallic shoe segments* for 100% power, trouble-free operation and longer life. These metallic shoes effectively control dissipation of heat energy; thus, the clutch easily absorbs the torture usually imposed on the prime mover, eliminates need for costly reduced-voltage starting equipment, and permits use of smaller motors to start high-inertia loads.

Completely automatic and entirely mechanical in operation, all Rawson clutches and clutch couplings provide full overload protection, never need adjustment.

SEND NOW FOR NEW CATALOG. For complete facts and specifications on the full line of Rawson Automatic Centrifugal Clutches and Clutch Couplings, send today for the FREE 1958 Rawson Catalog.

FORMSPRAG COMPANY

Distributorships available in selected areas. Write for details.



SALES AGENTS

23607 HOOVER ROAD, WARREN (DETROIT), MICHIGAN, PHONE: JEFFERSON 6-5100

Rawson Clutches and Clutch Couplings Manufactured Exclusively by Rawson Division of O. S. Walker Company

*Patent Pending

58RC-3

Prompt Service! Valuable Data!

reprints of editorial features . . .

more data about products advertised . . .

more information about materials and components . . .

copies of new catalogs and bulletins

Send in post-paid card, below . . . we'll do the rest!

NOW, you can use these handy prepared postcards to obtain any of these items:

REPRINTS OF EDITORIAL FEATURES can be obtained from PRODUCT ENGINEERING. Circle the key number in the space indicated. (Single copies will be sent as long as our supply lasts).

MORE DATA ABOUT MATERIALS AND COMPONENTS, described on pages 103-136, will be sent by the manufacturer. Just circle the appropriate key numbers.

COPIES OF NEW CATALOGS AND BULLETINS will be sent by manufacturer if you circle the key number. Bulletins are described on pages 138-143.

MORE INFORMATION ABOUT PRODUCTS ADVERTISED can be quickly obtained by circling the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement: T–Top; B–Bottom; R–Right; L–Left; TL–Top Left; BL–Bottom Left; TR–Top Right; BR–Bottom Right.

FOR SPECIALIZED DATA . . . prices, sizes available, nearest source of supply, etc. . . . circle key number and indicate your needs in the space allotted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

PLEASE TYPE OR PRINT

Name .....

Position .....

Company .....

Address .....

City and State.....5/12/58

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

5¢ Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING

330 WEST 42ND STREET

NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name .....

Position .....

Company .....

Address .....

City and State.....5/12/58

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

5¢ Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING

330 WEST 42ND STREET

NEW YORK 36, N. Y.

REPRINTS OF EDITORIAL FEATURES

CIRCLE KEY NUMBER TO RECEIVE COPIES OF THESE REPRINTS

E12. 7 ways to Start High-inertia Loads
Table presents performance of each basic method (3/3/58)

E13. Exotic Metals Seek Employment
Complete property data on nine tantalizing "rare" metals (3/17/58)

E14. Which Adhesive for What
Design guide and fast-reference table with application data (3/17/58)

E15. Textured Steel
New processes, texturing methods, design data and trends (3/17/58)

E17. Bearings for 300F and Up
Special materials and lubricants that give better performance for instrument bearings (2/3/58)

E18. Plastics for Abrasion Resistance
Properties tabulated for wear resisting elastometers and rigid plastics (3/31/58)

E19. K Factors
Charts give K-factors, for actual valves and fittings (4/14/58)

E20. Silicone Rubber Parts
Tips on curing methods, shape of parts and other variables that determine satisfactory service. (4/14/58)

E21. Fan Selection
Three fan laws; charts, tables and sample problems (4/28/58)

E22. Sandwich-Panel Facing Materials
Second of three articles gives data for selecting the skin material. (4/28/58)

E23. Midget Batteries
Power package for specialized applications. (5/12/58)

E24. Semiconductor Rectifiers
Comparison of germanium and silicone rectifiers. (5/12/58)

NEW COMPONENTS,

DESCRIPTION OF THESE NEW ENGINEERING

GENERAL ENGINEERING

38—Servo System Kit
39—Plotting Sheet
40—Frequency Meter
41—Budget-priced Diazo

METALS AND ALLOYS

16—Metal-filled Epoxy Resins

FABRICATION PROCESSES AND PRODUCTION

4—Urethane Rubber Parts

REPRINTS OF EDITORIAL FEATURES

E12 E13 E14 E15 E17 E18 E19 E20 E21 E22 E23 E24

MORE INFORMATION ABOUT PRODUCTS ADVERTISED

C2	1	2	4	6	8-9	10	11	12	13	14-5	16	17
18	27	28	29	30	31	32-3	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49	50	51	52
53	54	55	56	57	58	59	60	61	62	63	64	65
66	68	70	95	98	100	105	107	109	110	111	112	113
114	115	116	117	118	119	120	121	122	123	124	125	L126
R126	127	128	129	130	131	T132	B132	133	134	135	136	137
138	139	140	141	L142	R142	143	144	145	L146	TR146	BR146	147
L148	TR148	BR148	149	L150	R150	T151	B151	T152	BL152	BR152	T153	B153
L154	TR154	BR154	T155	B155	T156	BL156	BR156	L157	R157	L158	L159	R159
160	161	162	163	164	165	166	C3	C4				

MORE DATA ABOUT COMPONENTS AND MATERIALS

1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34	35	36	37	38	39
40	41											

COPIES OF NEW CATALOGS AND BULLETINS

42	43	44	45	46	47	48	49	50	51	52	53	54
55	56	57	58	59	60	61	62	63	64	65	66	

SPECIAL DATA _____

☐ *Enter my subscription to the new weekly* PRODUCT ENGINEERING *for one year.*
Card expires 7/12/58 1

REPRINTS OF EDITORIAL FEATURES

E12 E13 E14 E15 E17 E18 E19 E20 E21 E22 E23 E24

MORE INFORMATION ABOUT PRODUCTS ADVERTISED

C2	1	2	4	6	8-9	10	11	12	13	14-5	16	17
18	27	28	29	30	31	32-3	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49	50	51	52
53	54	55	56	57	58	59	60	61	62	63	64	65
66	68	70	95	98	100	105	107	109	110	111	112	113
114	115	116	117	118	119	120	121	122	123	124	125	L126
R126	127	128	129	130	131	T132	B132	133	134	135	136	137
138	139	140	141	L142	R142	143	144	145	L146	TR146	BR146	147
L148	TR148	BR148	149	L150	R150	T151	B151	T152	BL152	BR152	T153	B153
L154	TR154	BR154	T155	B155	T156	BL156	BR156	L157	R157	L158	L159	R159
160	161	162	163	164	165	166	C3	C4				

MORE DATA ABOUT COMPONENTS AND MATERIALS

1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34	35	36	37	38	39
40	41											

COPIES OF NEW CATALOGS AND BULLETINS

42	43	44	45	46	47	48	49	50	51	52	53	54
55	56	57	58	59	60	61	62	63	64	65	66	

SPECIAL DATA _____

☐ *Enter my subscription to the new weekly* PRODUCT ENGINEERING *for one year.*
Card expires 7/12/58 2

NEW CATALOGS

DESCRIBED ON PAGES 138-143

GENERAL ENGINEERING

55—Oscillographic Recording Equipment, 16 pp., Sanborn Co.

56—Electrometer-Megohmmeter, 4 pp., Walter N. Trump Co.

METALS AND ALLOYS

47—Anodized Strip Conductor, 12 pp., Reynolds Metals Co.

57—Chromium-Alloy Coating, 24 pp., Electrolizing Corp.

NON-METALLIC MATERIALS, FINISHES

44—Polyurethanes, 3 brochures, American Latex Products Corp.

51—Plastics for Electronics, 4 pp., Emerson & Cuming, Inc.

58—All-purpose Epoxy Casting Resin, 4 pp., Rezolin, Inc.

62—Stabilized Ceramics, 8 pp., Norton Co.

63—Cushioning Cork, 2 pp., Korfund Co., Inc.

FABRICATION PROCESSES AND PRODUCTION

53—Structural Sandwich, 4 pp., Zahorski Engineering, Inc.

66—Casting Pattern Design, 2 pp., Alloy Steel Casting Co.

POWER TRANSMISSION

64—Speed Reducers, Gears, 180 pp., Grant Gear Works, Inc.

ONE YEAR SUBSCRIPTION
26 DESIGN EDITIONS, 26 RESEARCH AND DEVELOPMENT EDITIONS
PLUS ANNUAL DESIGN DIGEST ISSUE

PARTS, MATERIALS AND FINISHES . . .

EMS APPEAR ON PAGES 103-136. CIRCLE KEY NUMBER FOR ADDITIONAL INFORMATION.

POWER TRANSMISSION
20—Automatic Transmission
22—High Speed Transmission Belts

MECHANICAL PARTS
2—Dual-purpose Seal
24—Welded Metal Bellows
34—Top-plate Conveyor Chain

FASTENING AND JOINING
9—Bonded Rubber Rod Ends
15—Self-tapping Stop Nuts
21—Nylon Flare Nuts
32—O-ring Tube Fitting

MOTORS, ENGINES AND CONTROLS
1—"Voice" Coil Actuates Clutch
3—Recorder Counts Jolts
5—Variable Speed Drive
7—Digital Voltmeter
8—Timer Limits Contact Bounce
6—Recycling Timers and Kits
11—Numerical Control Package
14—Two Wound Rotor Motors
23—Variable Speed Control
26—Hysteresis Clutch
28—Variable Speed Drive
35—Heavy-duty Foot Switches
36—Rerated NEMA Ac Motors

ELECTRICAL, ELECTRONIC COMPONENTS
10—Pressure and Vacuum Switches
13—Miniature Relay
18—Subminiature Delay Relays
17—Hermetically Sealed Switch
30—High-amperage Switches
37—Indicating Light Assortment

HYDRAULIC, PNEUMATIC COMPONENTS
12—Air Poppet Valve
12—Dual-spool Air Valve
25—Hydraulic Pumps and Motors
27—In-line Filter
29—Fluid Power Cylinders
31—High-temp Hydraulic Pump
33—Manifold Mounted Valves

AND BULLETINS . . .

CIRCLE KEY NUMBERS FOR YOUR COPY

MECHANICAL PARTS

43—Mechanical Components, 24 pp., Pic Design Corp.

46—Molded, Extruded, and Die-cut Parts, 28 pp., Miller Products Co.

49—Rubber and Synthetic Parts, 6 pp., Mechanical Rubber Products Co.

52—Vibration, Shock Mounting Systems, 4 pp., Federal Shock Mount Corp.

59—Plastic Rod and Tubes, 2 pp., Ace Plastics Co.

MOTORS, ENGINES AND CONTROLS

48—Adjustable Speed Drives, 8 pp., General Electric Co.

60—Thermistor-probe Assemblies, 4 pp., Fenwal Electronics, Inc.

61—Diesel Engines, 16 pp., Allis-Chalmers Mfg. Co.

65—Tape Control Systems, 12 pp., Bendix Aviation Corp.

ELECTRICAL, ELECTRONIC COMPONENTS

45—Relays, Solenoids, Switch Assemblies, 36 pp., Comar Electric Co.

50—Snap-acting Switches, 28 pp., W. L. Maxson Corp.

54—Electrical Components, 26 pp., Koontz-Wagner Electric Co., Inc.

HYDRAULIC, PNEUMATIC EQUIPMENT

42—Hydraulic Equipment, 64 pp., Dynex, Inc.

YEAR, U.S.A. AND POSSESSIONS—$5.00

YEAR CANADA—$7.00

YEAR, OTHER COUNTRIES—$25.00

REPRINTS OF EDITORIAL FEATURES

E12 E13 E14 E15 E17 E18 E19 E20 E21 E22 E23 E24

MORE INFORMATION ABOUT PRODUCTS ADVERTISED

C2	1	2	4	6	8-9	10	11	12	13	14-5	16	17
18	27	28	29	30	31	32-3	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49	50	51	52
53	54	55	56	57	58	59	60	61	62	63	64	65
66	68	70	95	98	100	105	107	109	110	111	112	113
114	115	116	117	118	119	120	121	122	123	124	125	L126
R126	127	128	129	130	131	T132	B132	133	134	135	136	137
138	139	140	141	L142	R142	143	144	145	L146	TR146	BR146	147
L148	TR148	BR148	149	L150	R150	T151	B151	T152	BL152	BR152	T153	B153
L154	TR154	BR154	T155	B155	T156	BL156	BR156	L157	R157	L158	L159	R159
160	161	162	163	164	165	166	C3	C4				

MORE DATA ABOUT COMPONENTS AND MATERIALS

1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34	35	36	37	38	39
40	41											

COPIES OF NEW CATALOGS AND BULLETINS

42	43	44	45	46	47	48	49	50	51	52	53	54
55	56	57	58	59	60	61	62	63	64	65	66	

SPECIAL DATA _____

☐ *Enter my subscription to the new weekly* PRODUCT ENGINEERING *for one year.*
Card expires 7/12/58 3

REPRINTS OF EDITORIAL FEATURES

E12 E13 E14 E15 E17 E18 E19 E20 E21 E22 E23 E24

MORE INFORMATION ABOUT PRODUCTS ADVERTISED

C2	1	2	4	6	8-9	10	11	12	13	14-5	16	17
18	27	28	29	30	31	32-3	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49	50	51	52
53	54	55	56	57	58	59	60	61	62	63	64	65
66	68	70	95	98	100	105	107	109	110	111	112	113
114	115	116	117	118	119	120	121	122	123	124	125	L126
R126	127	128	129	130	131	T132	B132	133	134	135	136	137
138	139	140	141	L142	R142	143	144	145	L146	TR146	BR146	147
L148	TR148	BR148	149	L150	R150	T151	B151	T152	BL152	BR152	T153	B153
L154	TR154	BR154	T155	B155	T156	BL156	BR156	L157	R157	L158	L159	R159
160	161	162	163	164	165	166	C3	C4				

MORE DATA ABOUT COMPONENTS AND MATERIALS

1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34	35	36	37	38	39
40	41											

COPIES OF NEW CATALOGS AND BULLETINS

42	43	44	45	46	47	48	49	50	51	52	53	54
55	56	57	58	59	60	61	62	63	64	65	66	

SPECIAL DATA _____

☐ *Enter my subscription to the new weekly* PRODUCT ENGINEERING *for one year.*
Card expires 7/12/58 4

You circle it! You get it!

- REPRINTS OF EDITORIAL FEATURES
- MORE INFORMATION ABOUT PRODUCTS ADVERTISED
- MORE DATA ABOUT COMPONENTS AND MATERIALS
- COPIES OF NEW CATALOGS AND BULLETINS

PLEASE TYPE OR PRINT

Name .....
Position .....
Company .....
Address .....
City and State.....5/12/58

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

5¢ Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING

330 WEST 42ND STREET

NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name .....
Position .....
Company .....
Address .....
City and State.....5/12/58

FIRST CLASS
PERMIT No. 64
NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

5¢ Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING

330 WEST 42ND STREET

NEW YORK 36, N. Y.

Requests for information made through PRODUCT ENGINEERING'S Reader Service will be forwarded to the manufacturers as quickly as possible.

If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.

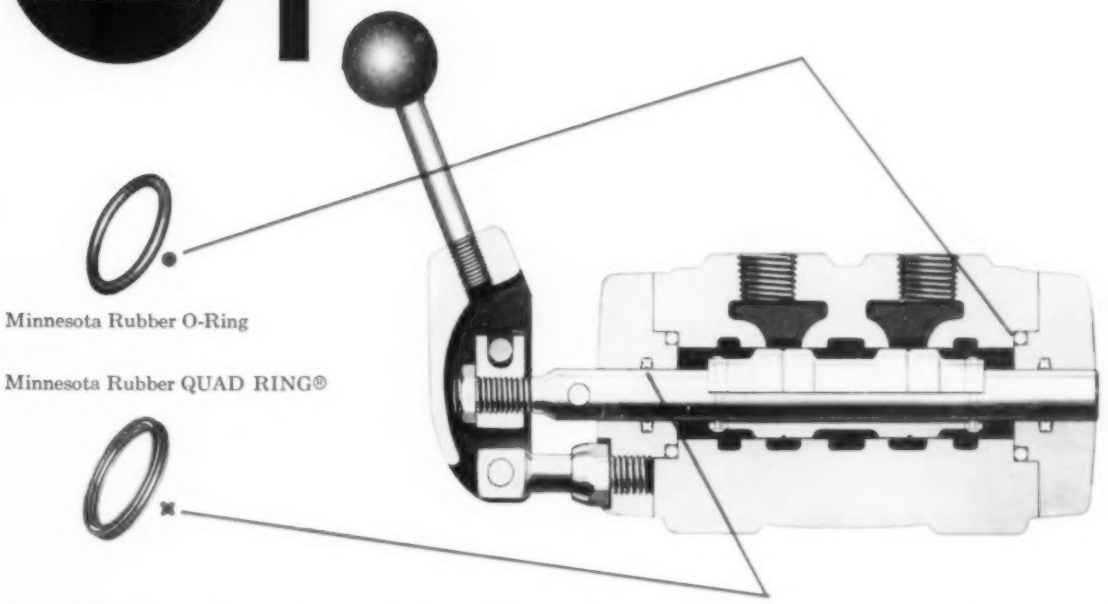
If you are not already a subscriber to PRODUCT ENGINEERING . . check the box at the bottom of the card.

hydraulics problem:

to improve operation of a pipe-mounted valve

problem solved by:

QUAD RINGS® and O-rings from minnesota rubber



Minnesota Rubber O-Ring

Minnesota Rubber QUAD RING®

To get the utmost in simple, smooth, leakproof operation from their Series 5000 pipe-mounted valve, Rivett, Inc., designed a special floating piston. This exclusive feature prevented sticking and binding by keeping the valve stem independent of the bore. However, it called for a stem seal that would greatly reduce friction.

Rivett found that seal in the Minnesota Rubber QUAD RING. They discovered that the QUAD RING required much less squeeze to make a perfect seal. The hydraulic valve makers found another Minnesota Rubber Product helpful, too.

Minnesota Rubber O-Ring cover seals eliminated and replaced gaskets. This gave three advantages: design simplicity, more efficient operation and longer life.

In fact, this combination of advanced design elements and Minnesota Rubber seals permits multi-million cycle operation at 1500 PSI.

The QUAD RING gives you 4-lip sealing action at less than 1 PSI. The QUAD RING requires only 60-100 micro-inch groove finish and eliminates spiral twist. An exclusive injection molding process makes Minnesota Rubber QUAD RINGS, O-Rings and other rubber parts denser and tougher than standard molded parts.

O-Rings from Minnesota Rubber are available with tolerances as close as ±.002". They cost as little as ordinary O-rings, yet are produced with no flash or other imperfections that require trimming. They are available in a broad range of standard sizes. Special sizes or compounds available on order. For full details on the O-Ring and QUAD RING, write to the department and address listed below. A 16-page facilities brochure is also available upon request.

Need low-cost prototypes? Another technique pioneered by Minnesota Rubber is KOTOKAST. This technique means rapid delivery of prototypes for experiment and development at a cost far below those made by standard processes. PROTOTYPES by KOTOKAST . . . another step forward by Minnesota Rubber Company.

Note: KOTOKAST is a trademark of the Minnesota Rubber Company.

MINNESOTA RUBBER COMPANY • 3630 Wooddale Avenue, Minneapolis 16, Minnesota, Department 261

for color in rubber
for parts of silicone rubber
for versatility in rubber
for applied product development

MINNESOTA MR RUBBER

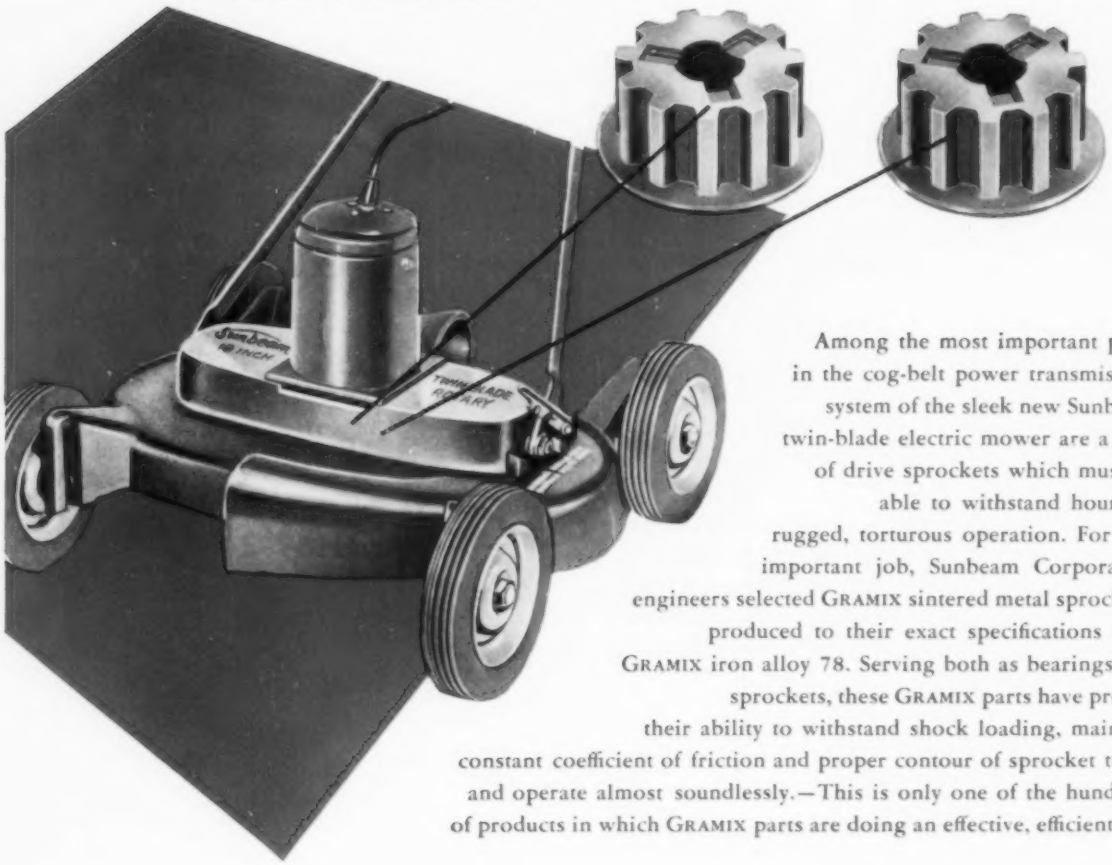
Rainbow Division
Silicone Division
Plastic and Latex Div.
Research Division

for their new electrical mower

Sunbeam engineers specify long wearing

GRAMIX® iron sprockets

(PRODUCT OF POWDER METALLURGY)



Among the most important parts in the cog-belt power transmission system of the sleek new Sunbeam twin-blade electric mower are a pair of drive sprockets which must be able to withstand hours of rugged, torturous operation. For this important job, Sunbeam Corporation engineers selected GRAMIX sintered metal sprockets, produced to their exact specifications with GRAMIX iron alloy 78. Serving both as bearings and sprockets, these GRAMIX parts have proved their ability to withstand shock loading, maintain constant coefficient of friction and proper contour of sprocket teeth, and operate almost soundlessly.—This is only one of the hundreds of products in which GRAMIX parts are doing an effective, efficient job.

Write for this book. Being die-pressed to shape, then sintered, GRAMIX parts usually cost less than machined pieces . . . yet can be produced to tolerances as close as .0005 inch. GRAMIX Bulletin No. 21 tells the whole story. Write today for your copy.

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 12, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® • POWDERED METAL PARTS MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES